



CONFLUENCE
consulting incorporated

DATE: September, 2012
TO: Poindexter Slough Design Review Committee
FROM: Confluence Consulting, Inc.
RE: Poindexter Slough Hydrologic Design Criteria

The following memo and appendices provide a summary of existing data collected on Poindexter Slough to support development of specific hydrologic design criteria for the restoration plan. This memo is meant to serve as a technical analysis of existing and proposed conditions, as well as an agenda of design criteria to discuss during a meeting with Confluence and the design review committee.

Data Summary

The following data have been collected on Poindexter Slough:

Topographic Survey Data:

- Longitudinal profile of entire Poindexter Slough channel
- 68 channel cross sections at riffles and pools in Poindexter Slough
- Survey of Poindexter Slough diversion on Beaverhead River
- Survey of Dillon Canal check structure and headgate

11 pebble counts at riffles

Discharge measurements:

- 3 synoptic flow sampling events at 12 stations in 2012
- FWP synoptic flow data from 2010, 2011

Reach Descriptions

Reach 1: Poindexter Slough diversion through straight, excavated ditch segment (STA 0+00 to 15+00)

Reach 2: Upper channel segment to backwatered reach (STA 15+00 to 120+00)

Reach 3: Backwatered reach affected by Dillon Canal check structure (STA 120+00 to 140+00)

Reach 4: Lower channel segment downstream of Dillon Canal to mouth (STA 140+00 to 250+00)

Data Analysis Components

Chart 1 – Synoptic Flow Measurement Results

Chart 2 - Estimated Hydrograph of Beaverhead River

Chart 3 - Poindexter Slough Discharge as a Function of the Beaverhead River Discharge

Chart 4 - Estimated hydrograph of Poindexter Slough

Table 1 – Flow Scenario Table

Table 2 - Comparison of Existing Channel Substrate to Calculated Transport Capability

Table 3: Existing Channel Geometry Summary Table

Appendix A - Cross section dimensions of existing channel

Appendix B – Channel Thalweg Profile of Poindexter Slough

Appendix C – HecRas Profile and Cross Sections

Appendix D – Hydraulic Results at Riffle Cross Sections for Spawning Suitability

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Appendix E – Incipient Motion Calculations for Base Flow and Flushing Flows

Synoptic Flow Measurements

Chart 1 includes results from synoptic flow measurements performed by Confluence between June and August of 2012. Flow monitoring was performed at 12 locations along the length of Poindexter Slough to quantify groundwater influence to the stream. In addition, flow monitoring data provided by Montana Fish Wildlife and Parks is included in the figure.

The average increase or decrease of flow measured by Confluence is plotted as a line in Chart 1. In general, Poindexter Slough gains approximately 17-32 cfs from the upstream headgate to the Dillon Canal and then gains 13 – 14 cfs from the Dillon Canal to the Beaverhead River downstream.

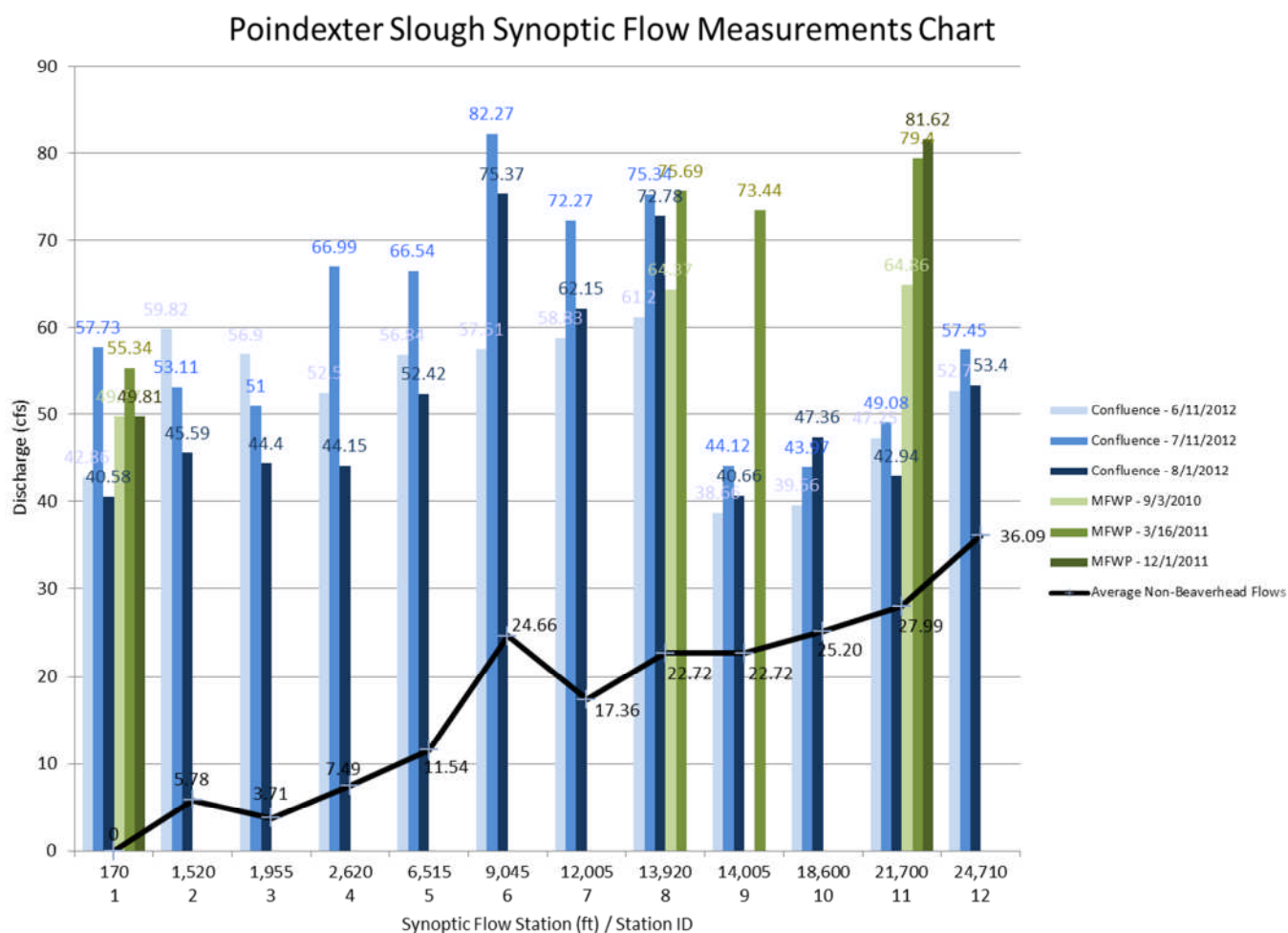


Chart 1 : Synoptic Flow Measurement Results

Beaverhead and Poindexter Hydrology

Chart 2 provides an estimated hydrograph of the Beaverhead River at the Poindexter Slough Headgate. The discharge values were formulated by subtracting the mean discharge of the East Bench Irrigation Canal mean daily discharges from mean discharge of the mean daily discharges on Beaverhead River obtained from USGS Stream Gage Data from Barrett's Gage #06016000. It is assumed that no additional significant gains or losses occur between the East Bench Irrigation District's headgate and the Poindexter Slough headgate. The hydrograph is based on gage data from 1997 to 2012.

Low flow discharges from November to March were not available from gage data. Historical average discharge data for the Clark Canyon Reservoir was obtained from the Bureau of Reclamation to provide estimated low flow discharges. The discrepancy between the average discharges from the two sets of data is likely the result of the difference in periods of data.

The operating plan for the Clark Canyon Reservoir states that whenever an adequate water supply is available, releases from the Dam will be maintained between 100-200 cfs. During below normal years, it may be necessary to reduce the releases to as low as 25-30 cfs.

Beaverhead River at Headgate of Poindexter Slough Mean Daily Discharge

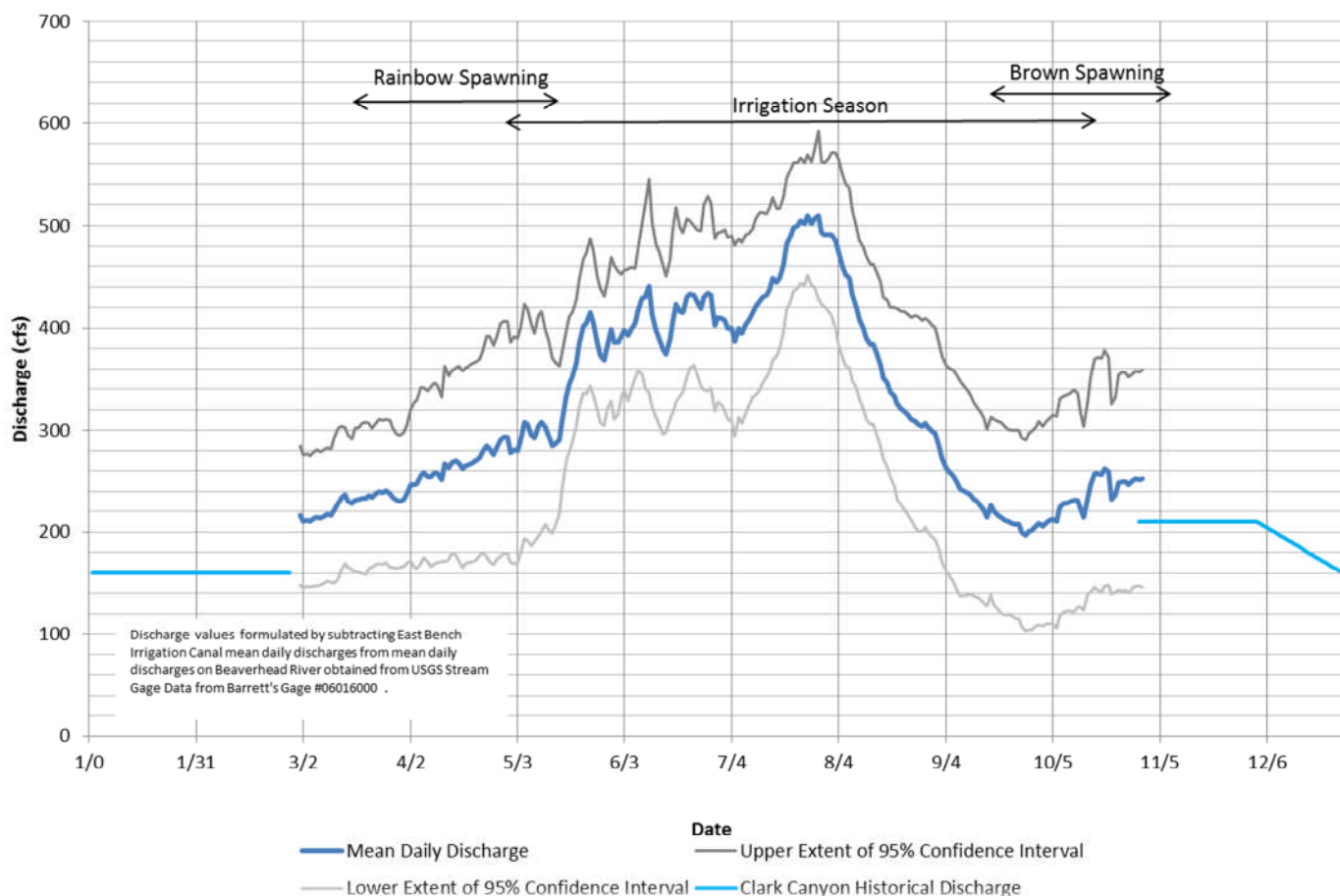


Chart 2 : Beaverhead River Hydrograph at Poindexter Slough

Chart 3 provides a discharge relationship between the Beaverhead River at the headgate of Poindexter Slough and Poindexter Slough. HEC-RAS software was used to develop a model of the existing headgate at the upstream end of Poindexter Slough, based on cross sections surveyed on the Beaverhead River and Poindexter Slough. The chart indicates discharges in Poindexter Slough as a function of discharges on the Beaverhead River.

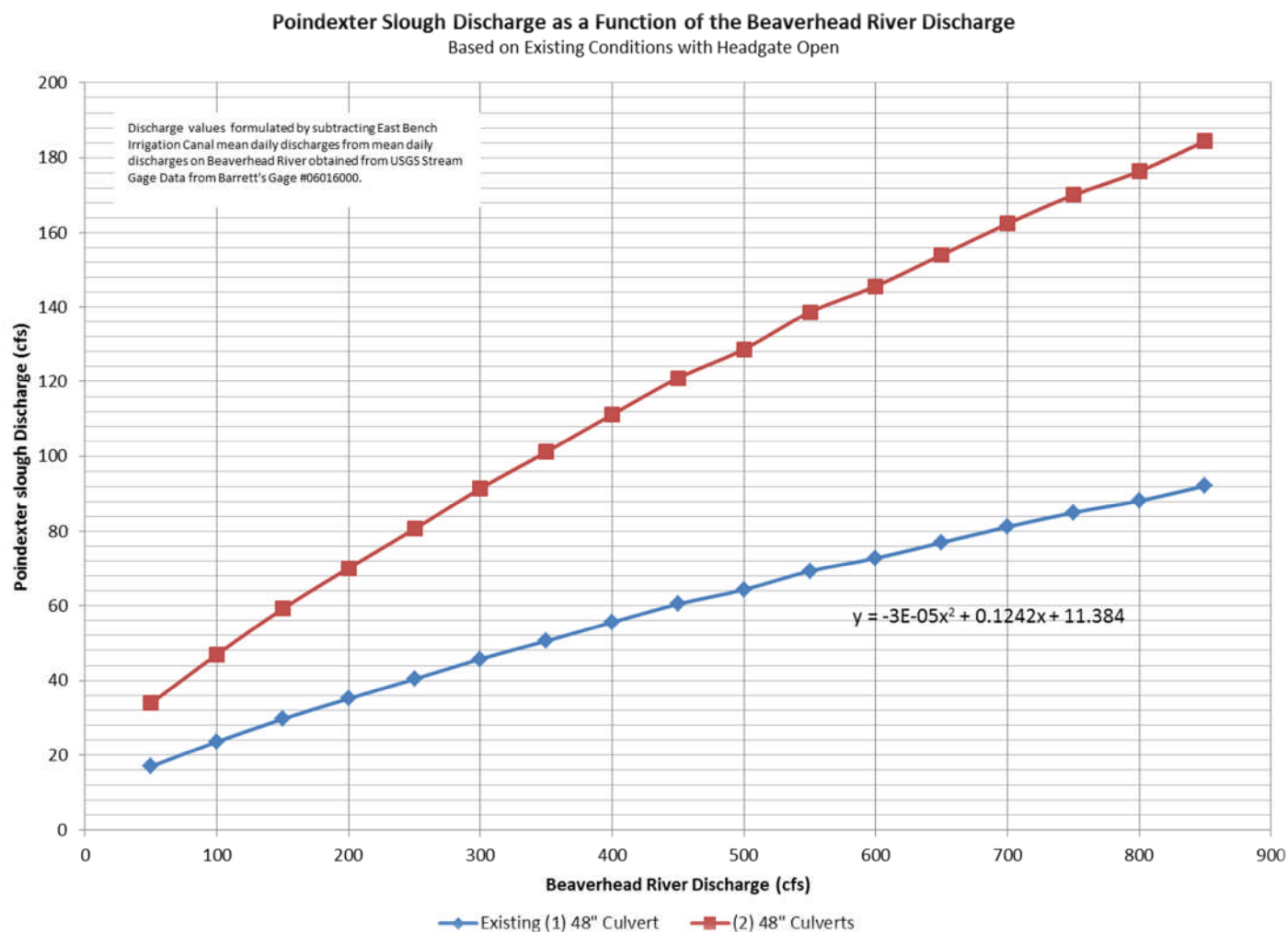


Chart 3: Poindexter Slough Discharge as a Function of the Beaverhead River Discharge

Chart 4 provides an estimated hydrograph of Poindexter Slough based on the Beaverhead River Hydrograph depicted in Chart 2 and the discharge relationship between the Beaverhead River and Poindexter Slough provided in Chart 3. The hydrograph is based on the existing headgate fully open. Low flow discharges are based on historical average discharge data for the Clark Canyon Reservoir obtained from the Bureau of Reclamation.

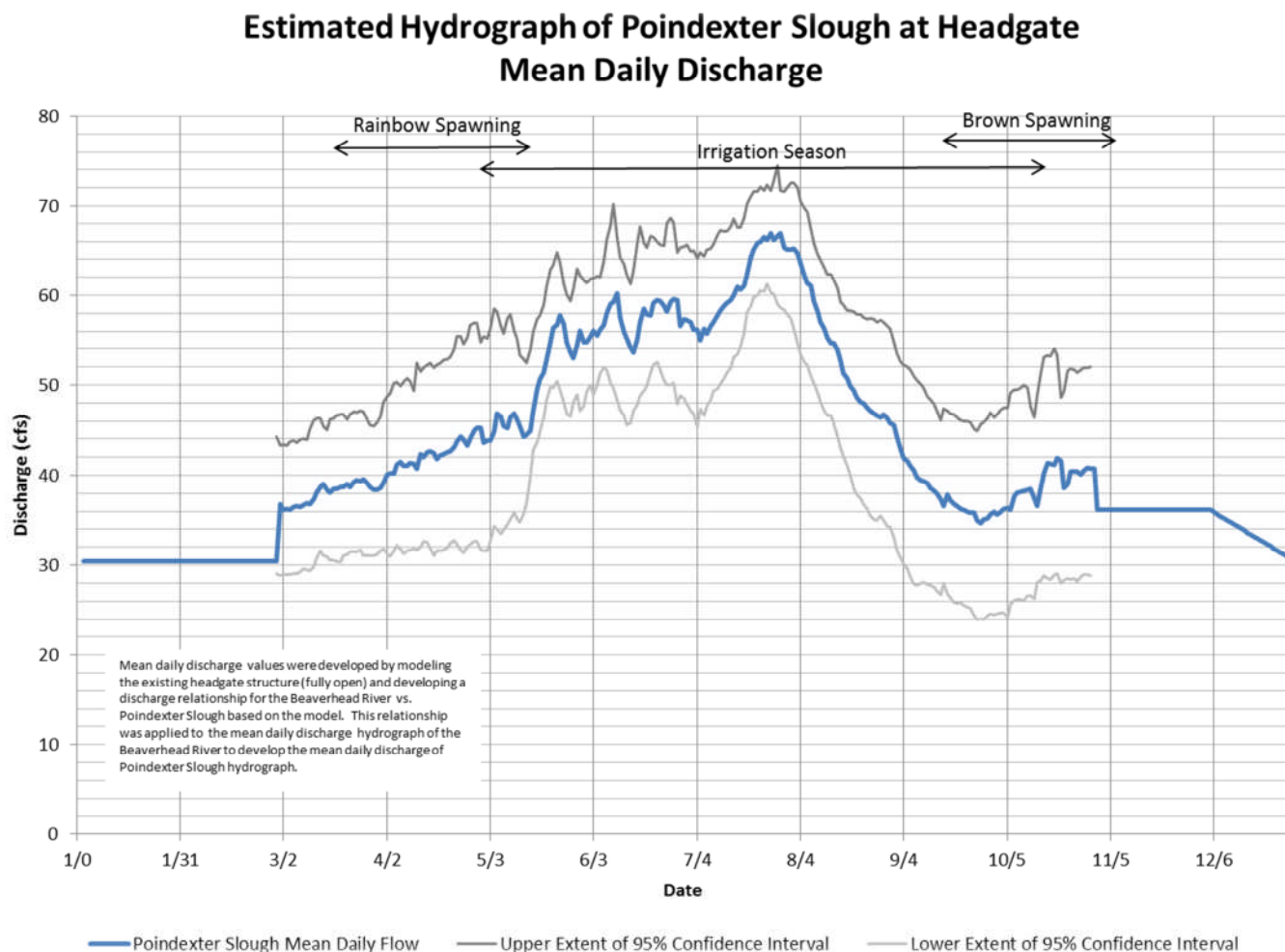


Chart 4: Poindexter Slough Hydrograph

Proposed Flow Scenarios and Hydraulics

Table 1 provides four discharge scenarios for Poindexter Slough. The proposed flow scenarios are based on three distinct flow periods including: Base Flow (Summer), Low Flow (winter), and a Flushing Flow (Spring). The table indicates a discharge at the upstream headgate proposed for each flow period as well as a gate condition at the Dillon Canal.

The synoptic flow results indicate a withdrawal from 22 cfs to 32 cfs from the Dillon Canal. It is understood that the Dillon Canal has water rights for 65 cfs. A flow scenario for the full 65 cfs was not included in this analysis. A normal operating discharge of 35 cfs was utilized to develop flow scenarios.

All flow scenarios include groundwater gains/losses based on an average of the gains/losses observed during the three synoptic flow measurements. Charts 5-8 include line graphs of each of the flow scenarios.

A HEC-RAS model was developed based on surveyed cross sections to analyze the hydraulics of Poindexter Slough at the proposed flow scenarios. Table 1 provides summary results of velocities and depths and an indication of the suitability of the flow scenario's ability to provide spawning habitat. Spawning criteria for rainbow and brown trout and detailed results for hydraulics at riffle cross sections are provided in Appendix D.

It is apparent from the hydraulic results that suitable spawning velocities and depths occur with the existing channel in both the proposed base flow and low flow conditions.

Scenario	Date	Upstream Headgate Discharge Scenario	Bottom of Reach 1-3	Riffle Velocity	Depth	Spawning	Canal Discharge Scenario	Top of Reach 4	Bottom of Reach 4	Riffle Velocity	Depth	Spawning
1	(Summer) March - October	Base Flow Q = 50	68 - 82	.64-2.75	.57-3.42	Good	Normal Operating Discharge Q = -35	33 - 47	45 - 61	.79-3.25	.92-3.76	Good
2	Winter	Winter Flow Q = 20	38 - 52	.37-2.63	.62-3.5	Good	Closed Q = 0	38 - 52	50 - 66	.98-2.2	.62-2.02	Good
3	(Spring) May-June	Flushing Flow Q = 100	118 - 132	NA	NA	NA	Normal Operating Discharge Q = -35	83 - 97	95 - 111	NA	NA	NA
4	(Spring) March						Closed Q = 0	118 - 132	130 - 146	NA	NA	NA

Table 1: Poindexter Slough Proposed Flow Scenarios

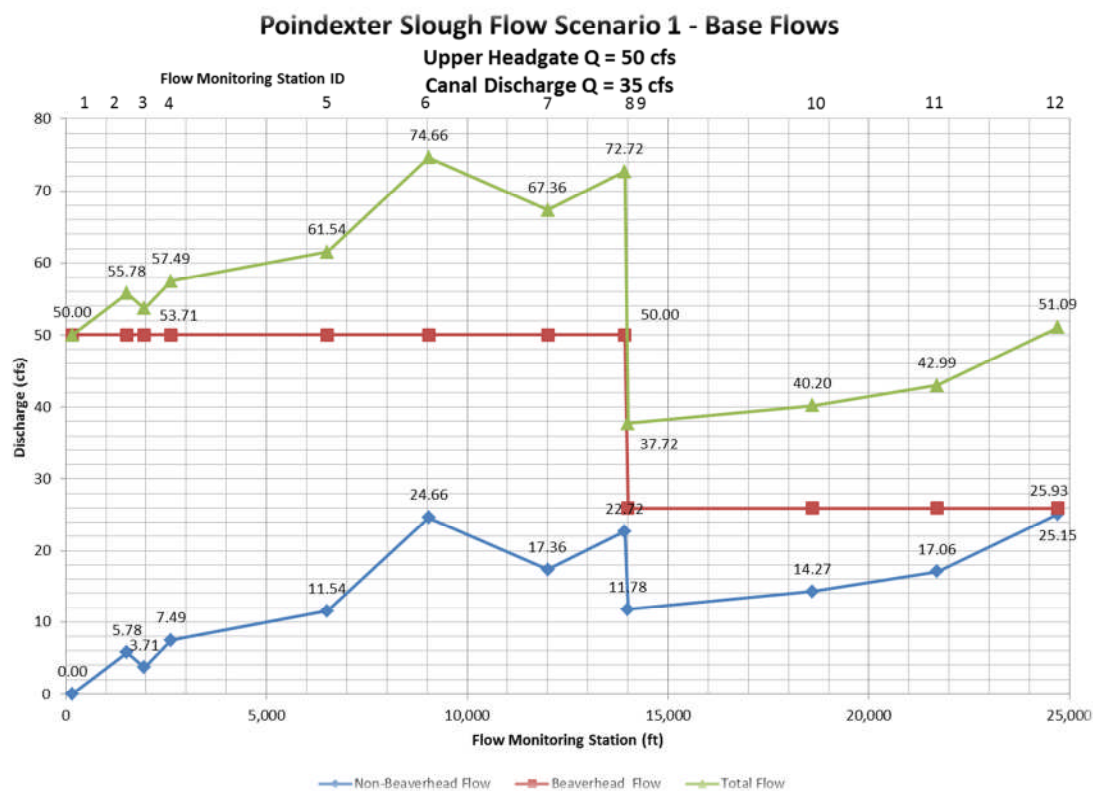


Chart 5: Flow Scenario 1

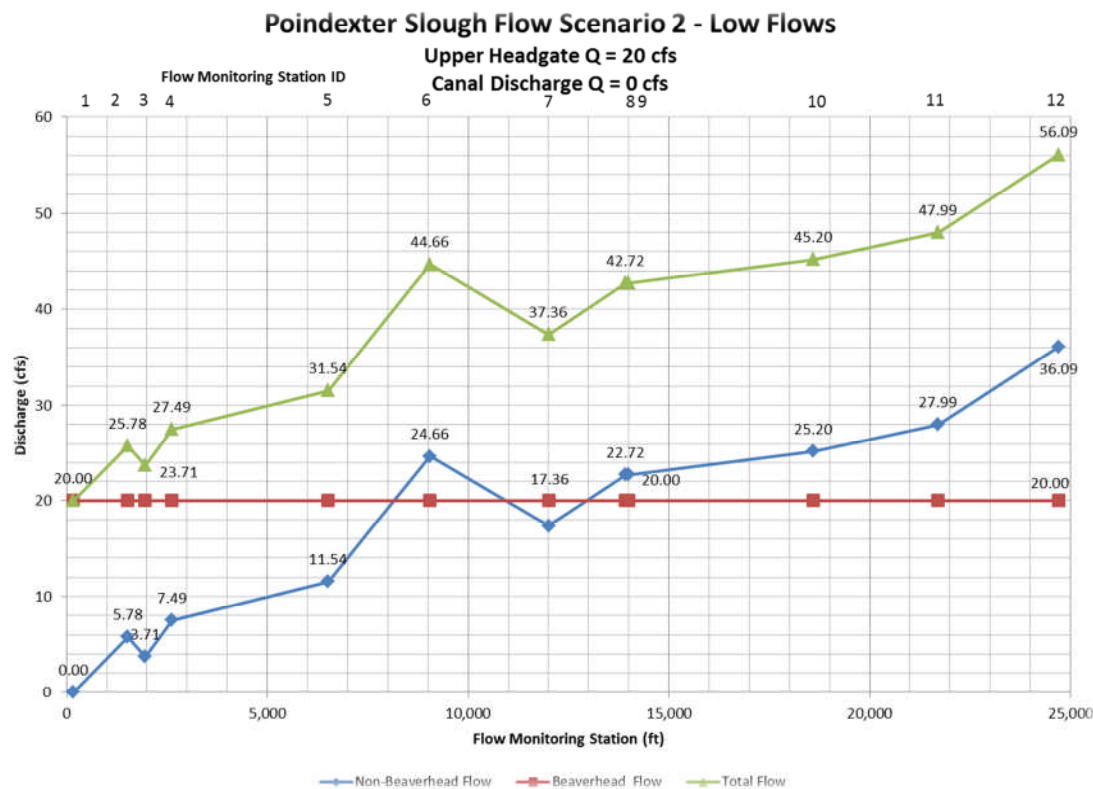


Chart 6: Flow Scenario 2

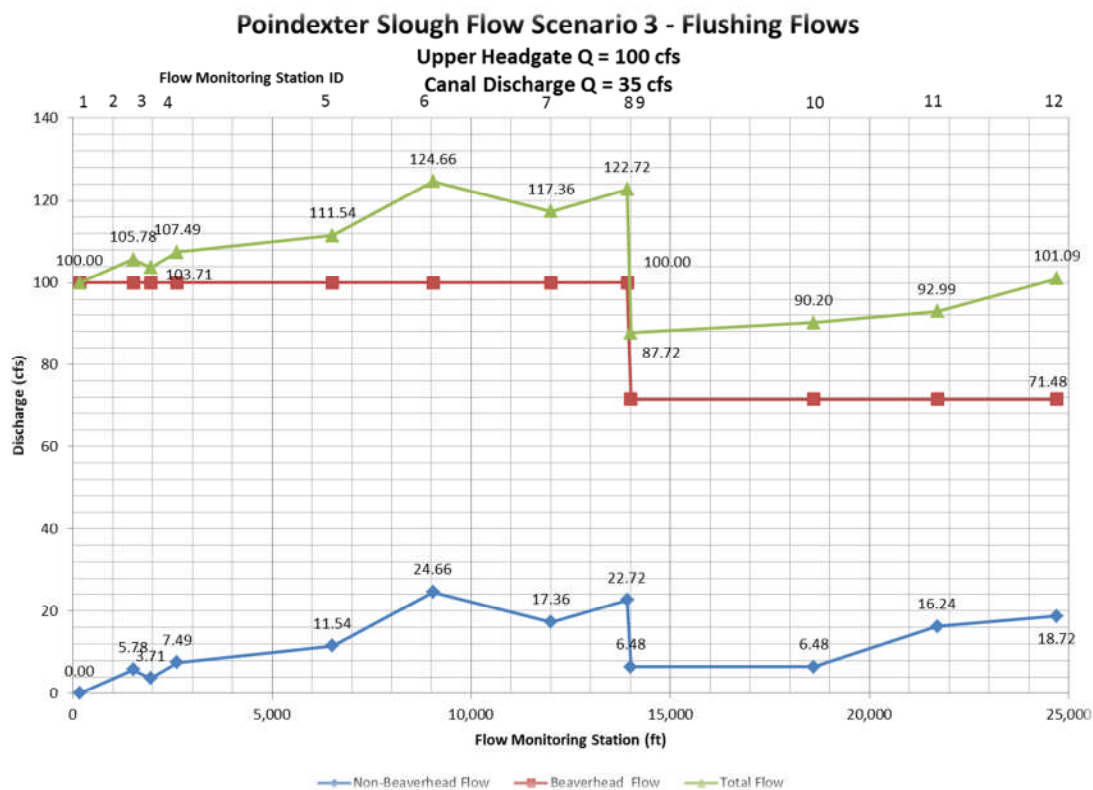


Chart 7: Flow Scenario 3

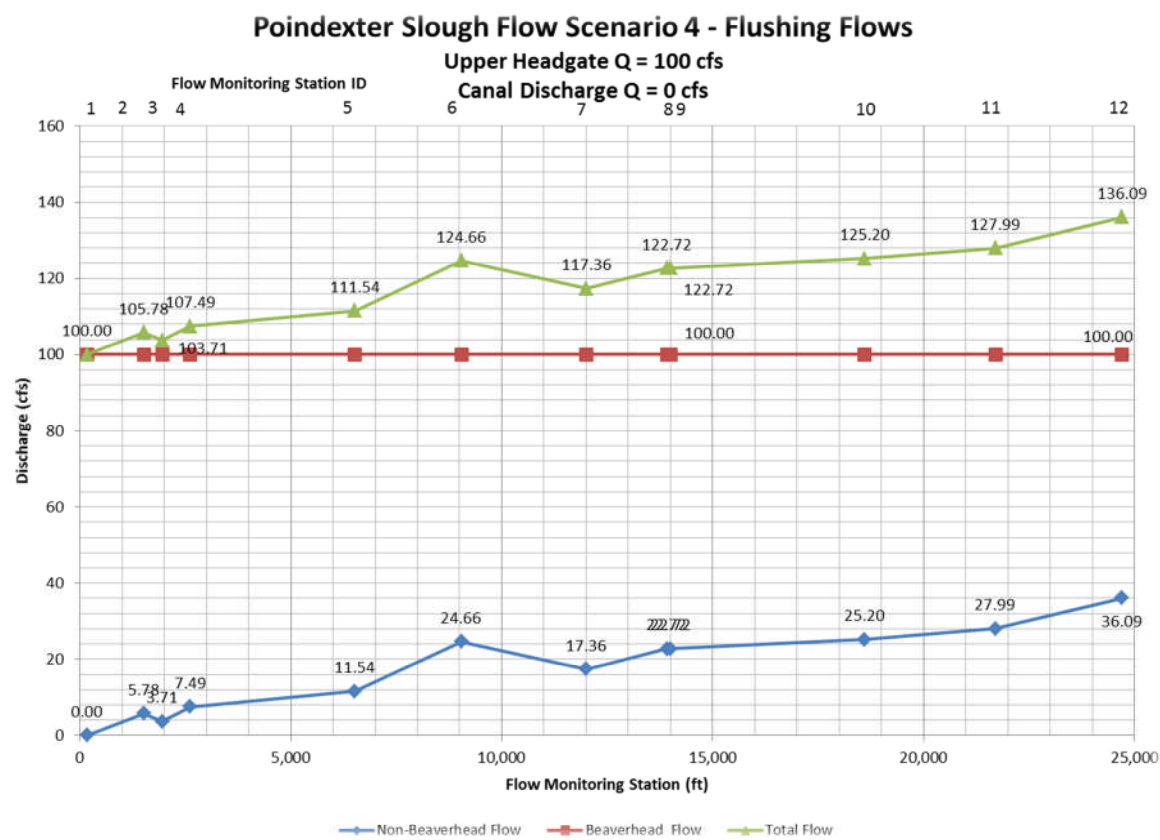


Chart 8: Flow Scenario 4

Sediment Transport

Pebble counts were conducted at 11 stations along Poindexter Slough during July, 2012. The pebble counts indicate that the channel exhibits a fairly uniform substrate gradation. Table 2 includes a condensed pebble count summary based on ranges of gradations measured within the designated reaches.

Incipient motion calculations were developed for flow scenarios 1, 3, and 4 using hydraulic output from the HEC-RAS model. The calculations were performed to evaluate the ability of the channel to transport fine sediment during base flows and to sort spawning gravels during flushing flows.

It is apparent from Table 2 that base flows will not sort spawning gravels but will move fine sediment. Flushing flows will move approximately the D₅₀ gravel size and will provide minimum sorting upstream of the Dillon Canal. Scenario 4 includes a flushing flow with the Dillon Canal gate closed, thus the ability of the reach downstream of the Dillon Canal headgate to sort gravels is slightly improved by the increased flow.

Reach	Field Measured Gradation		(2) Base Flow Q=50			(3) Flushing Flow Q=100 (Canal = 35 cfs)			(4) Flushing Flow Q=100 (Canal Closed)		
	D50 (in)	D84 (in)	Avg. Material Size Transported (in.)	Fine Sediment Transport Capability (< .08 in.)	Gravel Transport Capability (> .08 in.)	Avg. Material Size Transported (in.)	Fine Sediment Transport Capability (< .08 in.)	Gravel Transport Capability (> .08 in.)	Avg. Material Size Transported (in.)	Fine Sediment Transport Capability (< .08 in.)	Gravel Transport Capability (> .08 in.)
1	0.63	1.77	0.58	Good	Good	1.05	Good	Good	1.05	Good	Good
2	.63-.98	2.99 - 4.72	0.42	Good	Bad	0.62	Good	Good	0.62	Good	Good
3	0.91	4.72	0.15	Good	Bad	0.21	Good	Bad	0.18	Good	Bad
4	.63 - .91	4.13 - 4.72	0.25	Good	Bad	0.43	Good	Bad	0.51	Good	Bad

Table 2: Comparison of Existing Channel Substrate to Calculated Transport Capability

Reach	Length (ft)	Sinuosity	Pool Density (# Bankfull Widths / Pool)	Avg. Slope (ft/ft)	Pool					Riffles				
					Avg. X-Section Area (ft ²)	Avg. Top Width (ft)	Avg. Max. Depth (ft)	Avg. Dmean (ft)	Avg. W/D	Avg. X-Section Area (ft ²)	Avg. Top Width (ft)	Avg. Max. Depth (ft)	Avg. Dmean (ft)	Avg. W/D
Reach 1	1,500	1.16	NA	0.0013	118.70	37.60	5.01	3.16	11.91	45.56	23.11	2.38	1.97	11.72
Reach 2	10,500	1.63	6	0.0025	108.41	43.28	3.55	2.43	20.12	60.05	40.78	1.97	1.48	29.94
Reach 3	2,000	1.19	4	0.0018	131.95	47.63	4.71	6.84	8.21	113.92	50.38	3.04	2.27	22.60
Reach 4	9,000	1.88	5	0.0015	125.25	37.73	4.44	3.26	11.95	104.67	43.27	3.19	2.45	19.18

Table 3: Existing Channel Geometry Summary Table

Summary

- Based on the hydrology of the Beaverhead River and the hydraulics of the upstream headgate, it appears that the Beaverhead is capable of providing base flows (50 cfs) and low flows (20 cfs) with the existing infrastructure. However, in order to provide flushing flow, an additional culvert or other device(s) will be required.
- Fine sediments (2mm and smaller) can transport through the entire system at base flows (50 cfs) under the existing channel dimensions.
- Smaller sized fractions of spawning gravels (~0.5") will transport during flushing flows (100 cfs); however, larger spawning gravels will not sort unless larger flows are provided. If larger flows are conveyed, spawning gravels may need to be imported to prevent loss of suitable gravel materials.

- Sediment transport of smaller spawning gravels (~0.5") is more efficient in Reaches 1 and 2 than in Reaches 3 and 4, resulting in the potential for small gravel deposition in Reach 4. Narrowing the channel in Reach 4 will provide more efficient sediment transport and continuity with upper reaches.
- Existing channel dimensions are relatively close to what they should be with some reaches that will need to be narrowed/widened for suitable sediment transport. Specific areas will be identified in final design.
- Proposed base flows (50 cfs at head of Poindexter) and low flows (20 cfs at head of Poindexter) provide suitable spawning habitat characteristics
- Existing substrate composition is suitable for spawning
- Pool depths and density in some reaches are lacking, especially in Reach 2. Excavation of pool habitats is recommended. Constructing pool features will reduce spawning potential in pool tails for the short term unless either spawning gravels are imported or very large flows allow for natural sorting processes to occur.
- If a second pipe is installed with a capacity equal to that of the existing pipe, flushing flows must occur during irrigation season. Adding a third pipe with equivalent capacity will allow for flushing flows outside of the irrigation season.

Questions

1. What proportion of Beaverhead flow to Poindexter Slough flow is needed to retain the desired spring creek characteristics?
2. Is a withdrawal of 35 cfs from the Dillon canal acceptable for design purposes with the assumption that at least 60 cfs can be delivered to the canal at any given time?
3. When is Dillon Canal gate opened and closed?
4. Is a minimum winter flow of 20 cfs acceptable?
5. Are the spawning criteria acceptable?
6. Is it acceptable to provide flushing flow outside of irrigation season? What are the implications of this for fish? Spawning? Whirling Disease?
7. Is fish passage required at the Dillon Canal and the Beaverhead diversion?

Appendix A

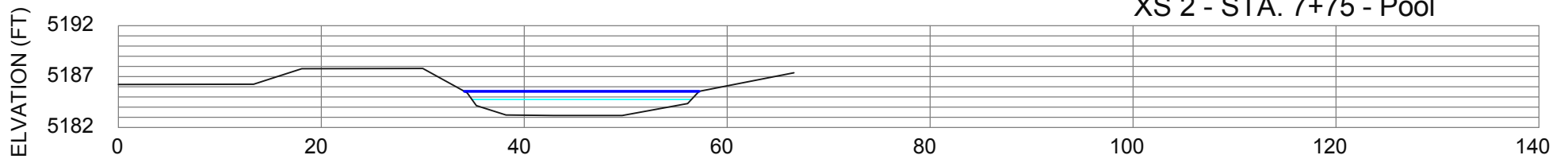
Cross Section Dimensions of Existing Channel

Poindexter Slough Cross Section Dimensions

Reach	XS	Type	Area (ft²)	W - Top Width (ft)	Dmax (ft)	Dmean (ft)	W/D
1	1	ditch	115	36.1	5.51	3.19	11.33
1	2	Pool	45.56	23.11	2.38	1.97	11.72
1	3	ditch	122.40	39.09	4.51	3.13	12.48
2	4	Pool	40.43	42	2.20	0.96	43.63
2	5	Riffle	55.4	37.1	1.86	1.49	24.84
2	6	Pool	68.75	40.52	2.97	1.70	23.88
2	7	Riffle	54.29	35.07	1.86	1.55	22.65
2	8	Riffle	78.00	43.59	2.49	1.79	24.36
2	9	Pool	83.07	35.28	3.20	2.35	14.98
2	10	Riffle	39.52	34.2	1.86	1.16	29.60
2	11	Pool	90.15	33.52	4.16	2.69	12.46
2	12	Riffle	54.29	33.36	2.01	1.63	20.50
2	13	Pool	130.89	39.61	4.34	3.30	11.99
2	14	Riffle	58.46	33.92	1.90	1.72	19.68
2	15	Pool	157.81	69.17	4.45	2.28	30.32
2	16	Riffle	114.99	47.27	3.31	2.43	19.43
2	17	Pool	227.5	63.21	5.41	3.60	17.56
2	18	Riffle	50.61	45.40	1.83	1.11	40.73
2	19	Pool	40.51	23.20	2.46	1.75	13.29
2	20	Pool	43.91	22.34	2.80	1.97	11.37
2	21	Pool	171.46	42.99	3.02	3.99	10.78
2	22	Riffle	38.45	35.03	1.35	1.10	31.91
2	23	Riffle	51.06	47.95	1.66	1.06	45.03
2	24	Riffle	42.81	46.98	1.01	0.91	51.56
2	25	Pool	57.1	33.62	2.46	1.70	19.80
2	26	Riffle	60.65	43.75	2.36	1.39	31.56
2	27	Pool	117.21	65.66	3.82	1.79	36.78
2	28	Riffle	57.45	46.54	1.65	1.23	37.70
2	29	Pool	180.55	51.52	4.83	3.50	14.70
2	30	Riffle	84.74	40.81	2.49	2.08	19.65
3	31	Riffle	81.36	41.46	2.73	1.96	21.13
3	32	Riffle	141.58	65.2	2.84	2.17	30.03
3	33	Pool	137.49	50.31	4.63	2.73	18.41
3	34	Pool	126.40	44.95	4.79	2.81	15.98
3	35	Riffle?	118.82	44.47	3.55	2.67	16.64
4	36	Pool	34.35	20.15	2.40	1.70	11.82
4	37	Riffle	106.04	50.41	2.43	2.10	23.96
4	38	Riffle	160.42	41.27	6.98	3.89	10.62
4	39	Pool	131.47	31.35	6.09	4.19	7.48
4	40	Pool	171.96	45.18	5.46	3.81	11.87
4	41	Riffle	128.66	40.3	5.02	3.19	12.62
4	42	Pool	120.95	40.3	4.24	3.00	13.43
4	43	Riffle	82.33	37.03	2.70	2.22	16.66
4	44	Riffle	80.32	37.53	2.68	2.14	17.54
4	45	Pool	168.4	41.04	6.16	4.10	10.00
4	46	Pool	98.17	36.65	3.77	2.68	13.68
4	47	Riffle	57.71	33.78	2.06	1.71	19.77
4	48	Pool	124.56	37.82	4.13	3.29	11.48
4	49	Riffle	139.63	51.54	3.44	2.71	19.02
4	50	Pool	91.70	36.42	4.14	2.52	14.46
4	51	Pool	132.57	37.28	4.57	3.56	10.48
4	52	Riffle	90.46	39.51	2.71	2.29	17.26
4	53	Riffle	97.05	52.38	2.33	1.85	28.27
4	54	Pool	163.64	55.89	4.32	2.93	19.09
4	55	Riffle	88.06	46.28	2.63	1.90	24.32
4	56	Riffle	122.38	53.04	2.82	2.31	22.99
4	57	Riffle	101.85	48.59	2.40	2.10	23.18
4	58	Pool	130.56	39.68	4.13	3.29	12.06
4	59	Pool	87.79	36.35	3.18	2.42	15.05
4	60	Riffle	97.32	41.65	2.92	2.34	17.82
4	61	Riffle	64.65	44.8	1.60	1.44	31.04
4	62	Pool	185.41	42.13	5.95	4.40	9.57
4	63	Pool	126.79	35.62	4.29	3.56	10.01
4	64	Pool	164.09	39.85	4.89	4.12	9.68
4	65	Riffle	137.3	33.84	4.82	4.06	8.34
4	66	Riffle	120.61	40.4	3.51	2.99	13.53
4	67	Pool	71.58	28.03	3.38	2.55	10.98

— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

XS 2 - STA. 7+75 - Pool



Profile view graph showing ELEVATION (FT) vs. STATIONING. The graph displays a proposed profile (blue line) and an existing profile (black line). The elevation ranges from 5179 to 5189 feet, and the stationing ranges from 0 to 140. The proposed profile is generally higher than the existing profile, with a significant drop in the existing profile between stations 40 and 60.

Profile view graph showing ELEVATION (FT) vs. STATIONING. The graph displays a proposed profile (blue line) and an existing profile (black line). The elevation ranges from 5177 to 5187 feet, and the stationing ranges from 0 to 140. The proposed profile is generally higher than the existing profile, with a significant drop in elevation between stations 50 and 90.

XS 9 - STA. 33+34

Stationing	Elevation (FT)
0	5178.0
15	5177.0
20	5176.5
30	5176.5
40	5176.5
48	5177.0
60	5178.0
65	5178.5

Profile view graph showing ELEVATION (FT) vs. STATIONING. The graph displays a proposed road profile (blue line) and existing ground profile (black line). The proposed profile is a straight line at 5178 feet from station 10 to 45, then drops to 5176 feet at station 45, and rises to 5178 feet at station 55. The existing ground profile starts at 5178 feet at station 0, drops to 5176 feet at station 10, remains at 5176 feet until station 35, and then rises to 5178 feet at station 55.

Profile view graph showing elevation (FT) vs stationing. The graph displays a proposed profile (blue line) and an existing profile (black line). The proposed profile is a straight line from station 0 to 115, then drops to a constant elevation of 5172.5 FT from station 115 to 120. The existing profile follows the proposed profile until station 45, then drops to 5172.5 FT at station 55, and then follows a different path, ending at 5172.5 FT at station 115. The graph is titled 'XS 15 - STA. 50+94'.

XS 17 STA: 02+17

Stationing	Brown Line (FT)	Blue Line (FT)	Green Line (FT)	Black Line (FT)
0	5174.5	-	-	-
5	5174.0	5172.0	-	-
10	5173.5	5171.8	5170.5	-
15	5168.0	5171.6	5169.5	5167.0
20	5168.0	5171.5	5169.5	5167.0
30	5168.0	5171.4	5169.0	5166.8
35	5167.5	5171.3	5167.0	5166.8
40	5167.0	5171.2	5167.0	5166.8
45	5167.0	5171.1	5167.0	5166.5
50	5167.5	5171.0	5167.5	5167.0
55	5168.0	5170.9	5170.0	5167.5
60	5169.0	5170.8	5170.0	5168.0
65	5170.0	5170.7	5170.5	5169.0
68	5171.0	5171.5	5170.5	5170.0
78	5174.0	-	-	-

Profile view graph showing elevation (FT) vs stationing. The graph displays a proposed profile (blue line) and an existing profile (black line). The proposed profile is a straight line from station 20 to 45, while the existing profile follows the ground line. The elevation ranges from 5165 to 5175 feet.

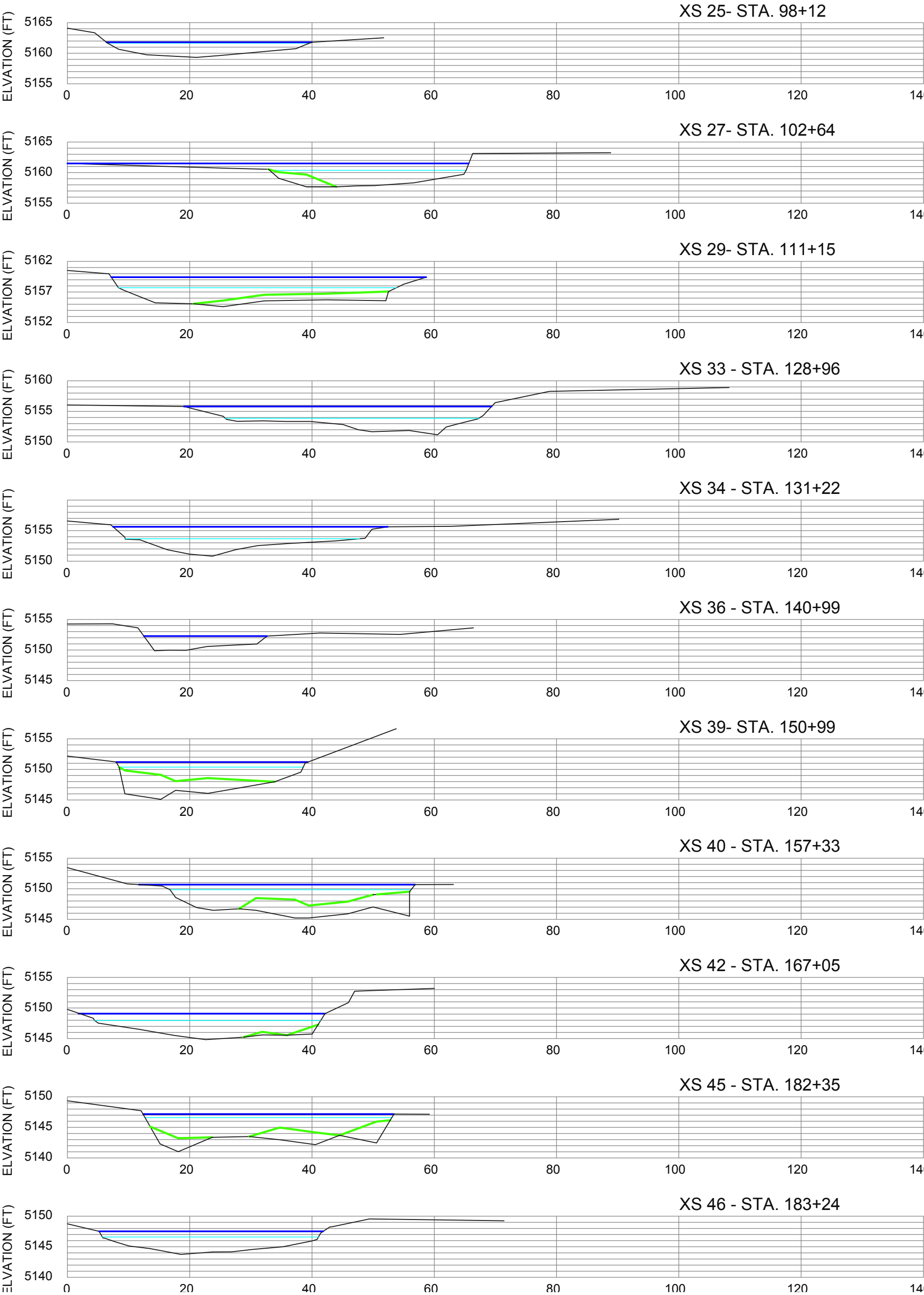
XS 21 - STA. 79+05

Station	Existing Ground Elevation (FT)	Proposed Grade Elevation (FT)
0	5169.0	5169.0
15	5168.5	5168.5
21	5166.5	5166.5
22	5164.5	5166.5
30	5163.5	5166.5
40	5165.0	5166.5
50	5166.0	5166.5
65	5166.5	5166.5
80	5166.5	5166.5
90	5168.0	5166.5

— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

Pool Cross Sections

SCALE: 1" = 15'



SHEET
2 OF 7



DRAWN RLB	CHECKED JL	APPROVED JL
DATE: 9/5/12		
FILE: poindexter xs.dwg		

POINDEXTER SLOUGH
FISH HABITAT IMPROVEMENT

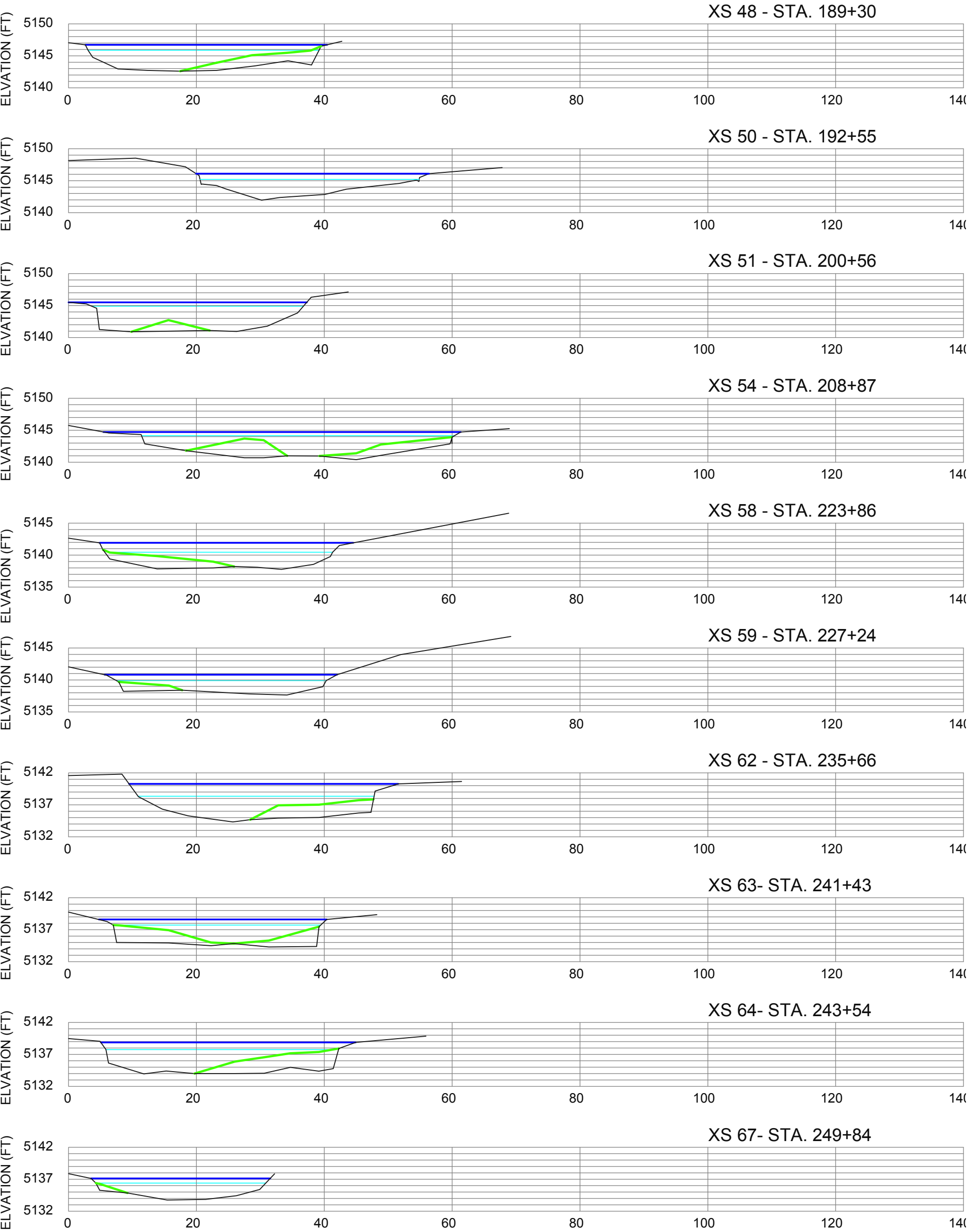
EXISTING CROSS-SECTIONS

NO.	BY	DATE	REVISION DESCRIPTION

— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

Pool Cross Sections

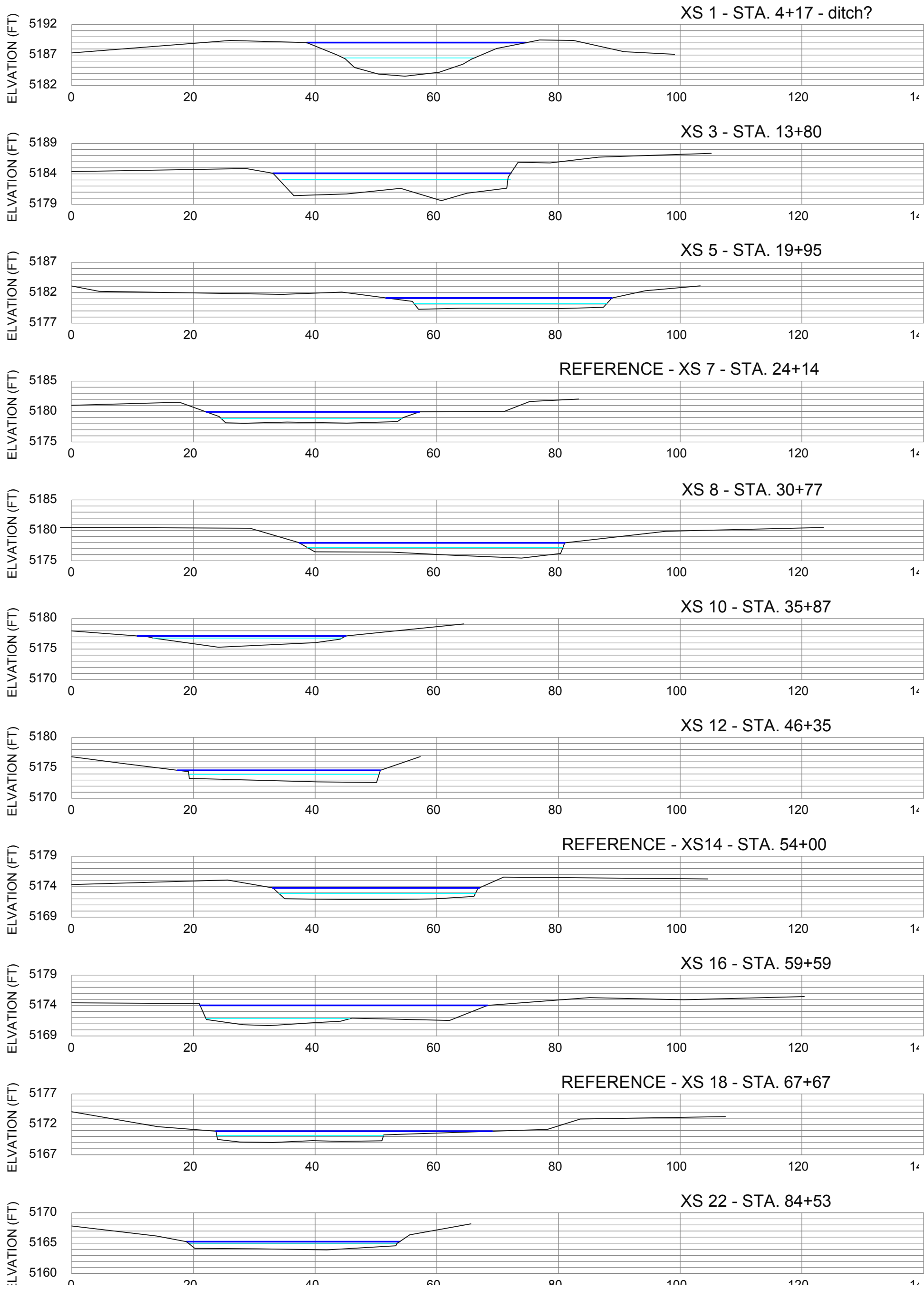
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- SURVEYED WATER SURFACE
- BANKFULL WATER SURFACE
- SEDIMENT

Riffle Cross Sections

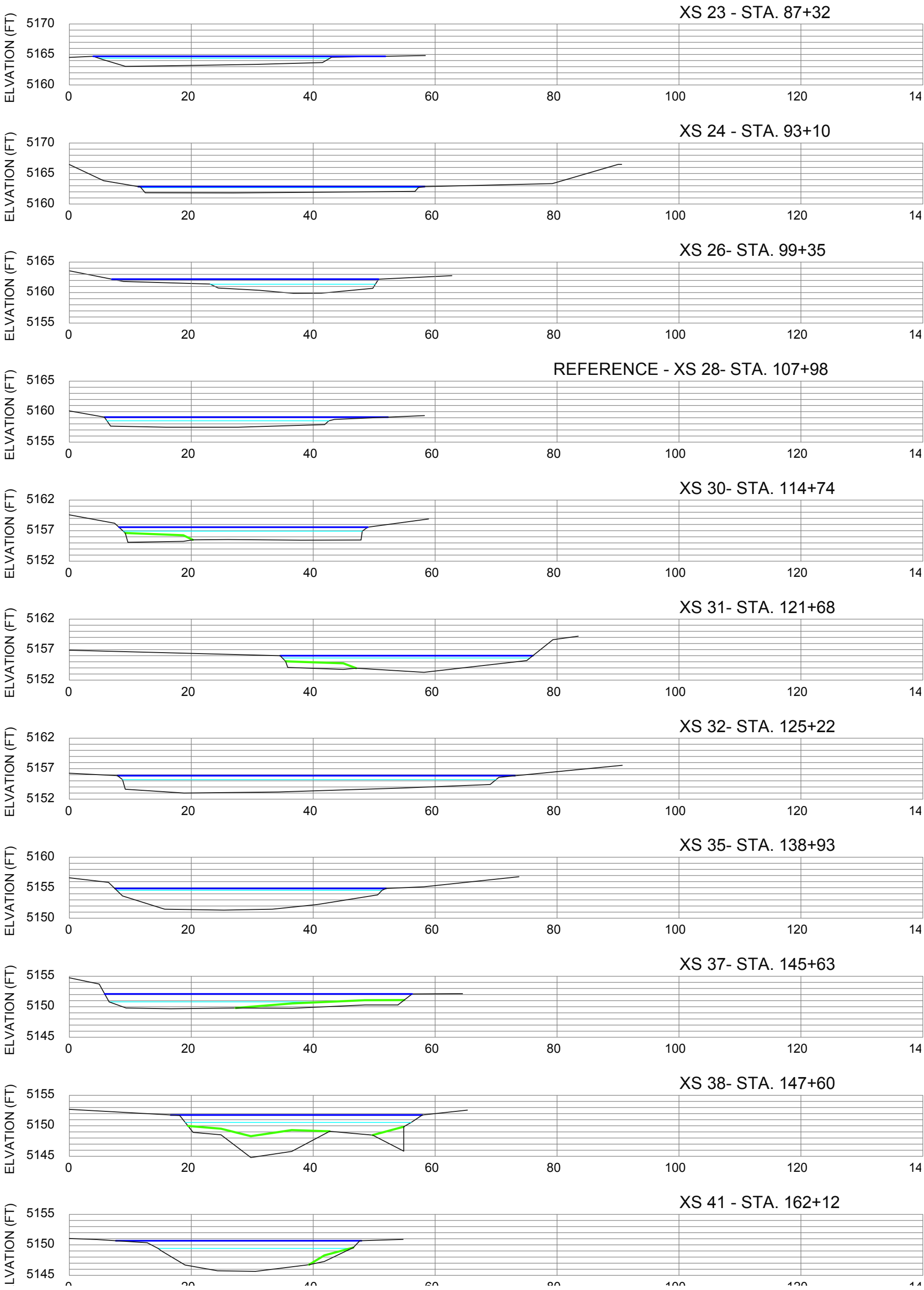
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— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

Riffle Cross Sections

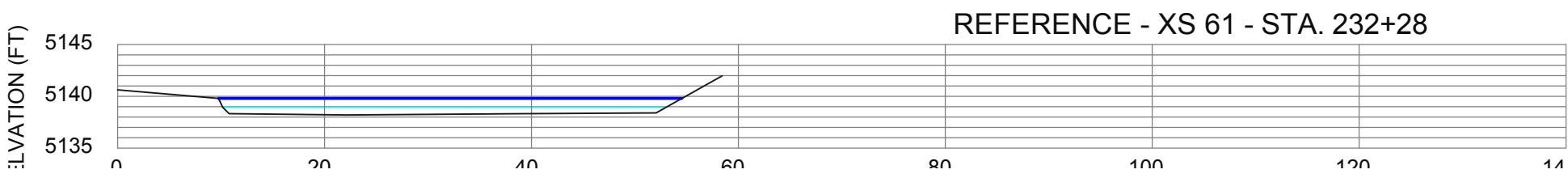
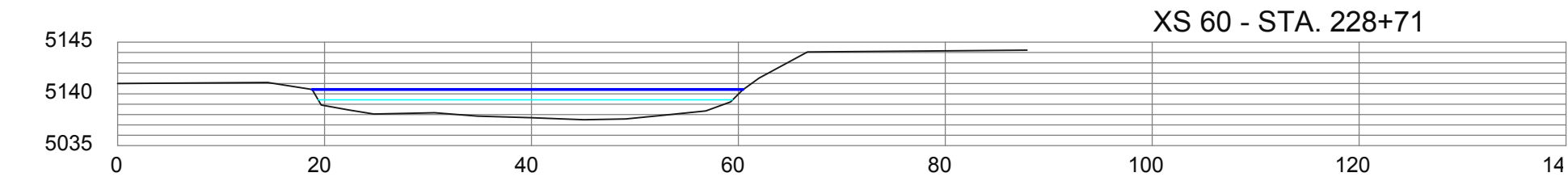
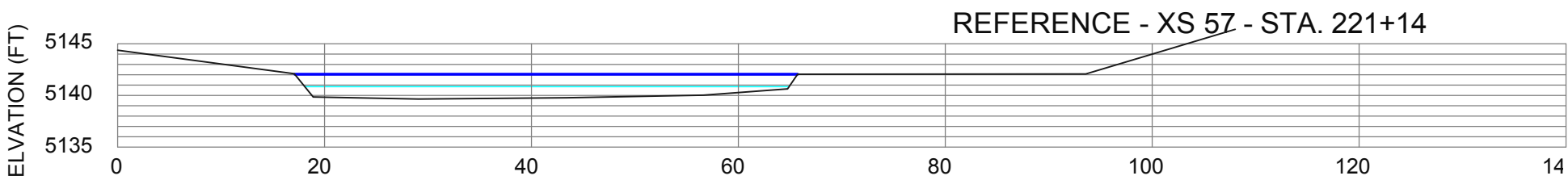
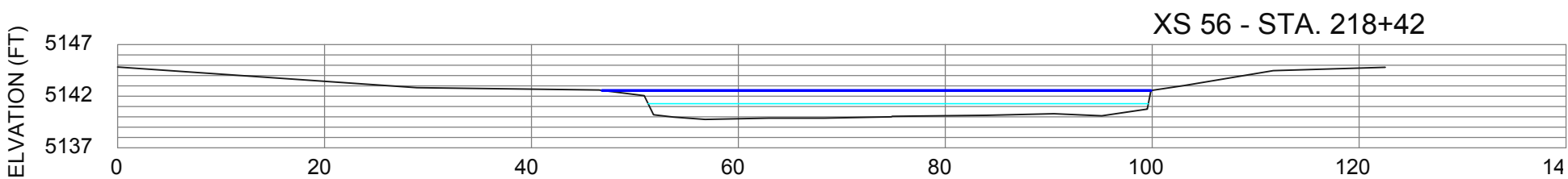
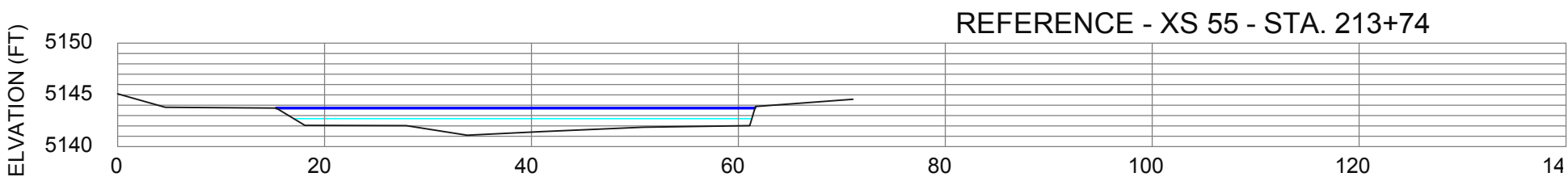
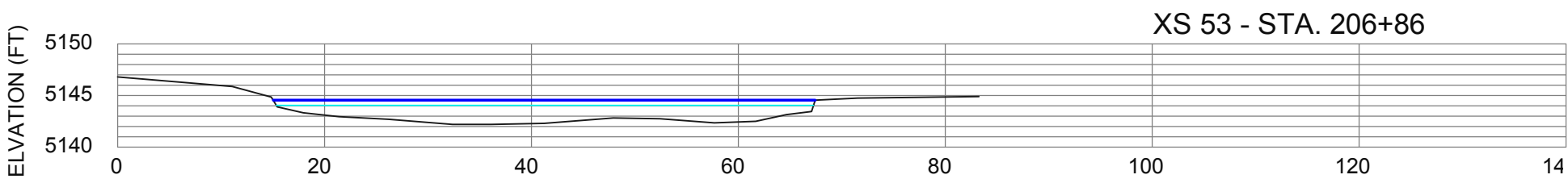
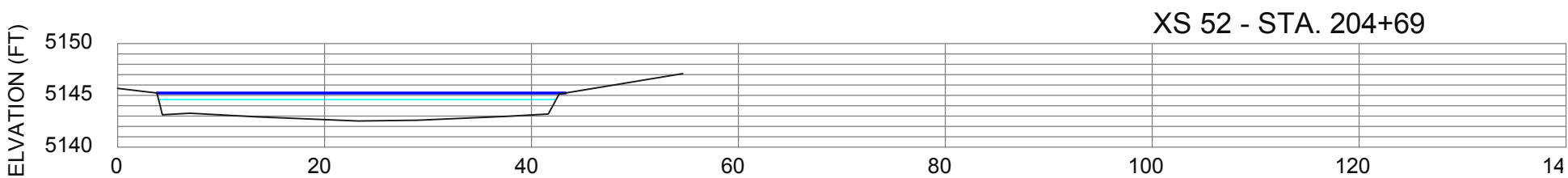
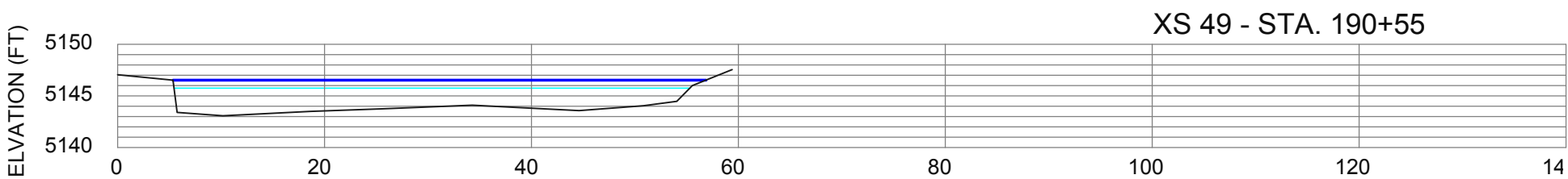
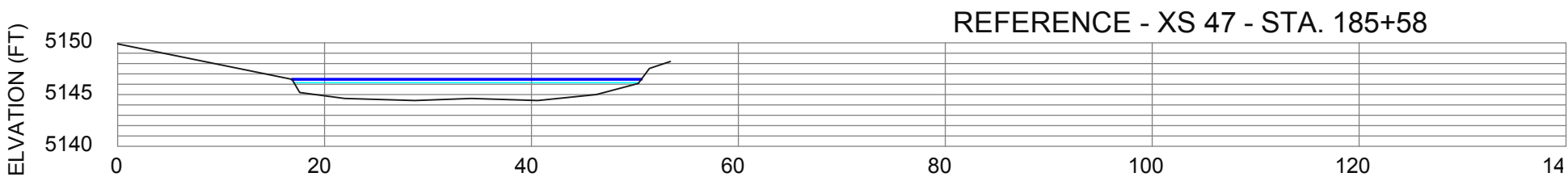
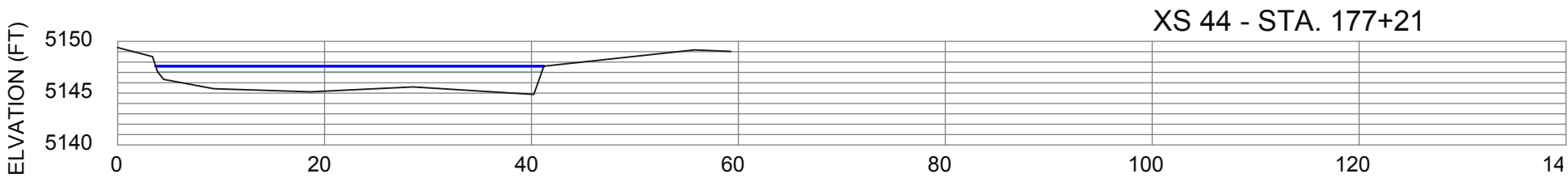
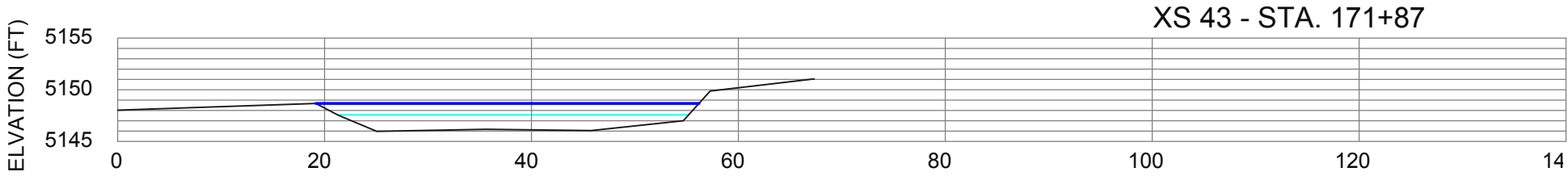
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— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

Riffle Cross Sections

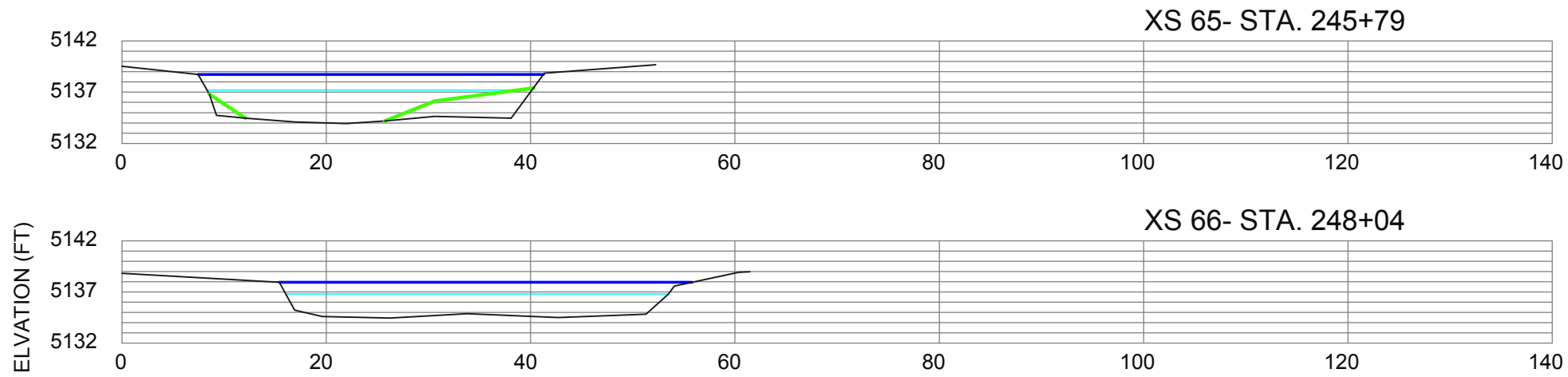
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— SURVEYED WATER SURFACE
— BANKFULL WATER SURFACE
— SEDIMENT

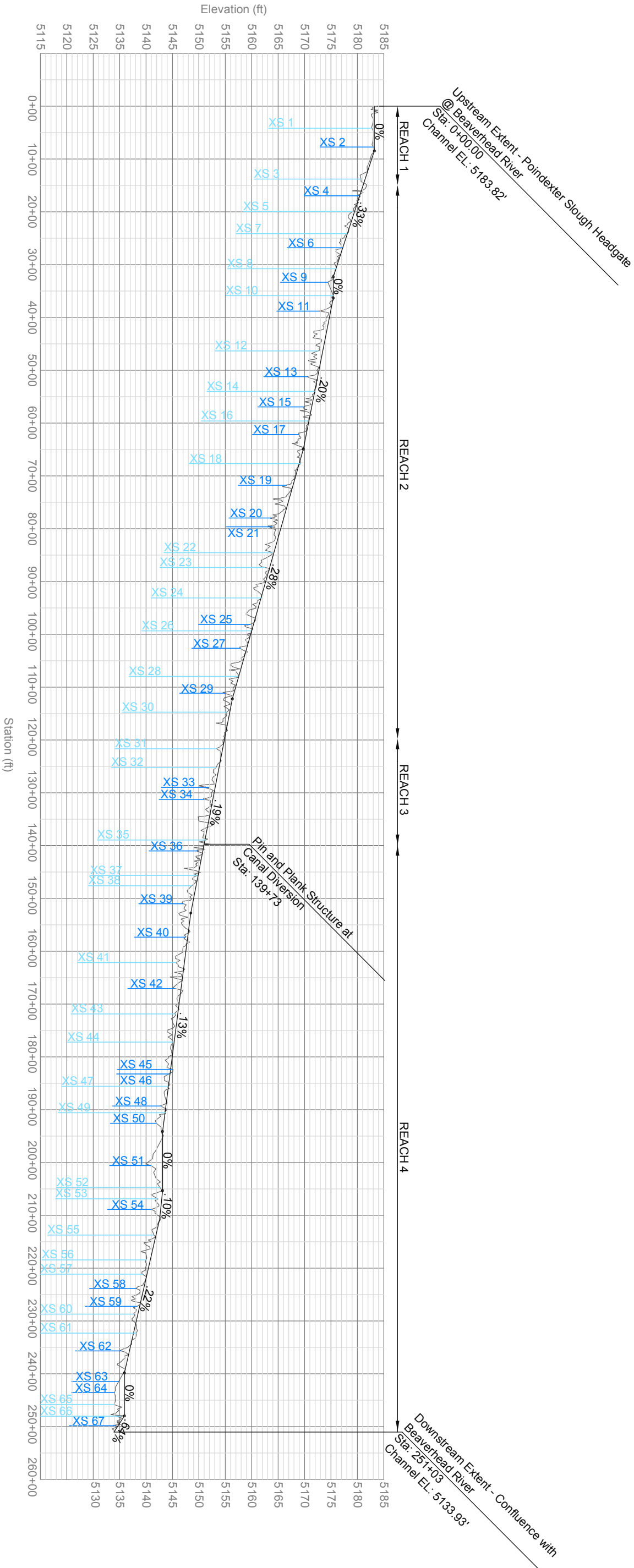
Riffle Cross Sections

SCALE: 1" = 15'



Appendix B

Channel Thalweg Profile of Poindexter Slough



Poindexter Slough Channel Bed Profile

HORIZONTAL SCALE: 1" = 2,000'
VERTICAL SCALE: 1" = 20'

- Pool Cross Section
- Riffle Cross Section
- Existing Channel Bed

REVISION DESCRIPTION				NO.	BY	DATE

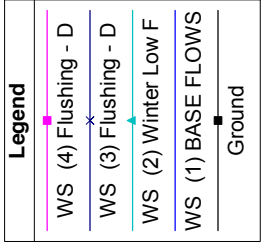
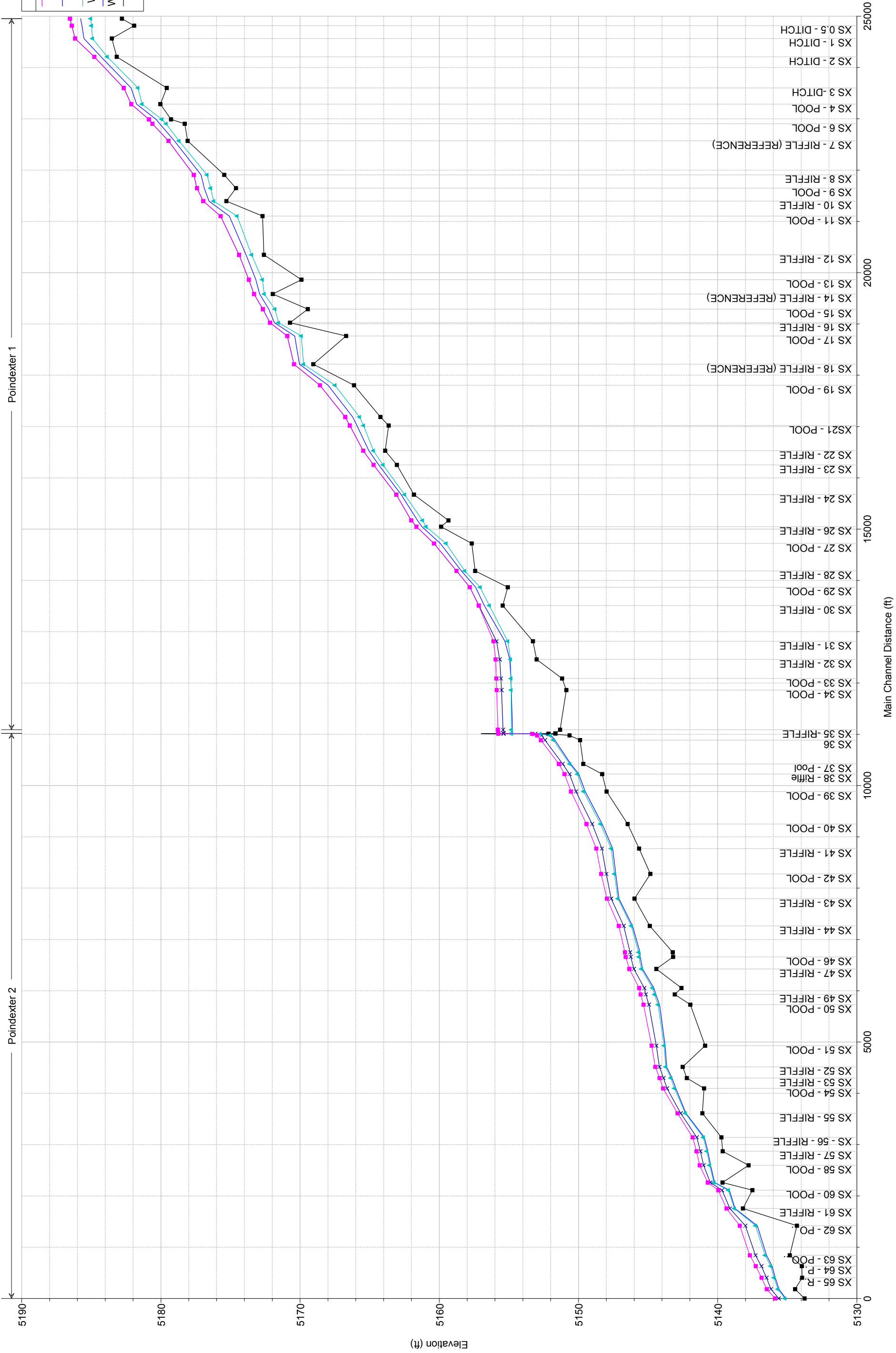
POINDEXTER SLOUGH FISH HABITAT IMPROVEMENT		
CHANNEL BED PROFILE		

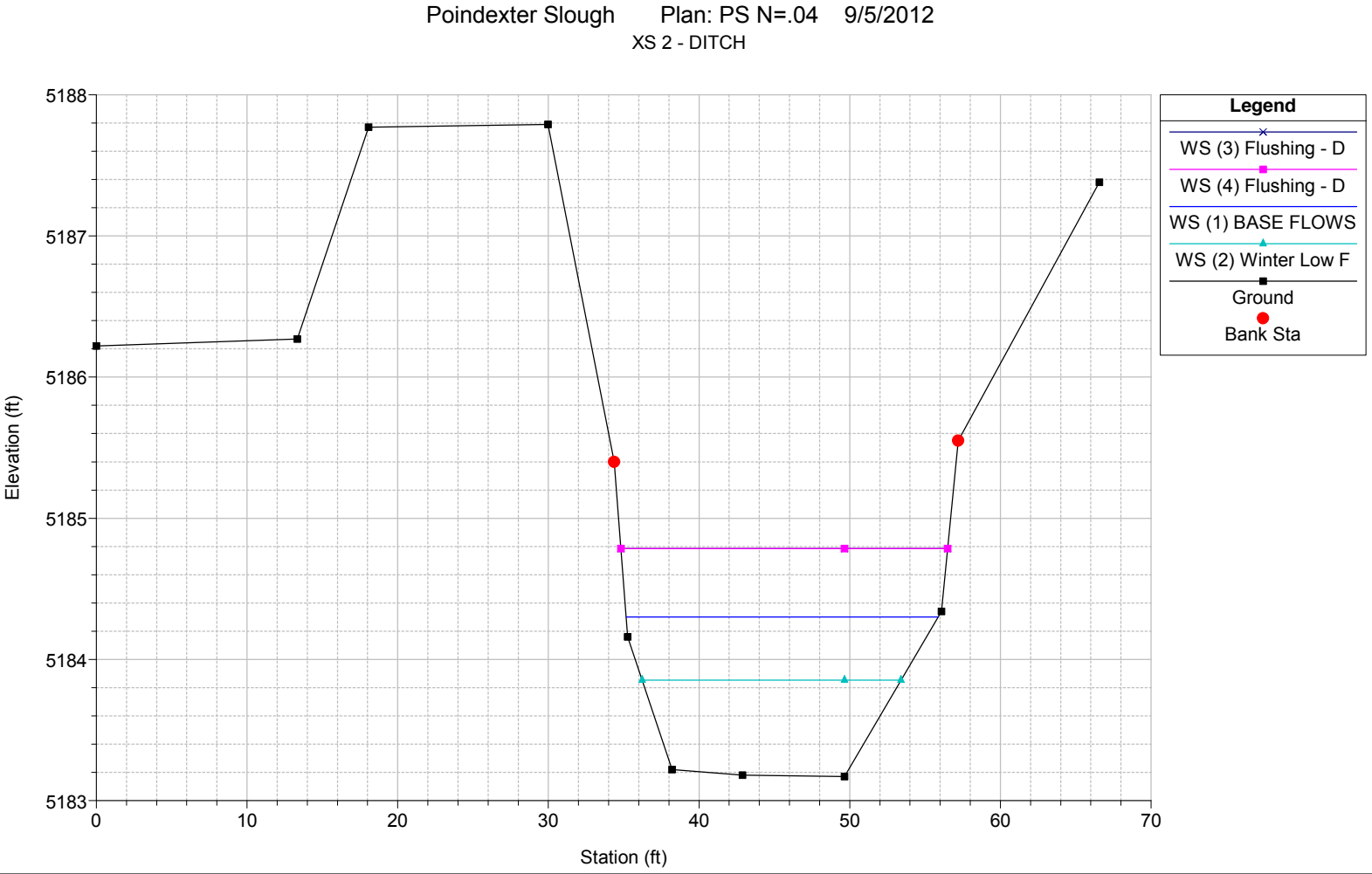
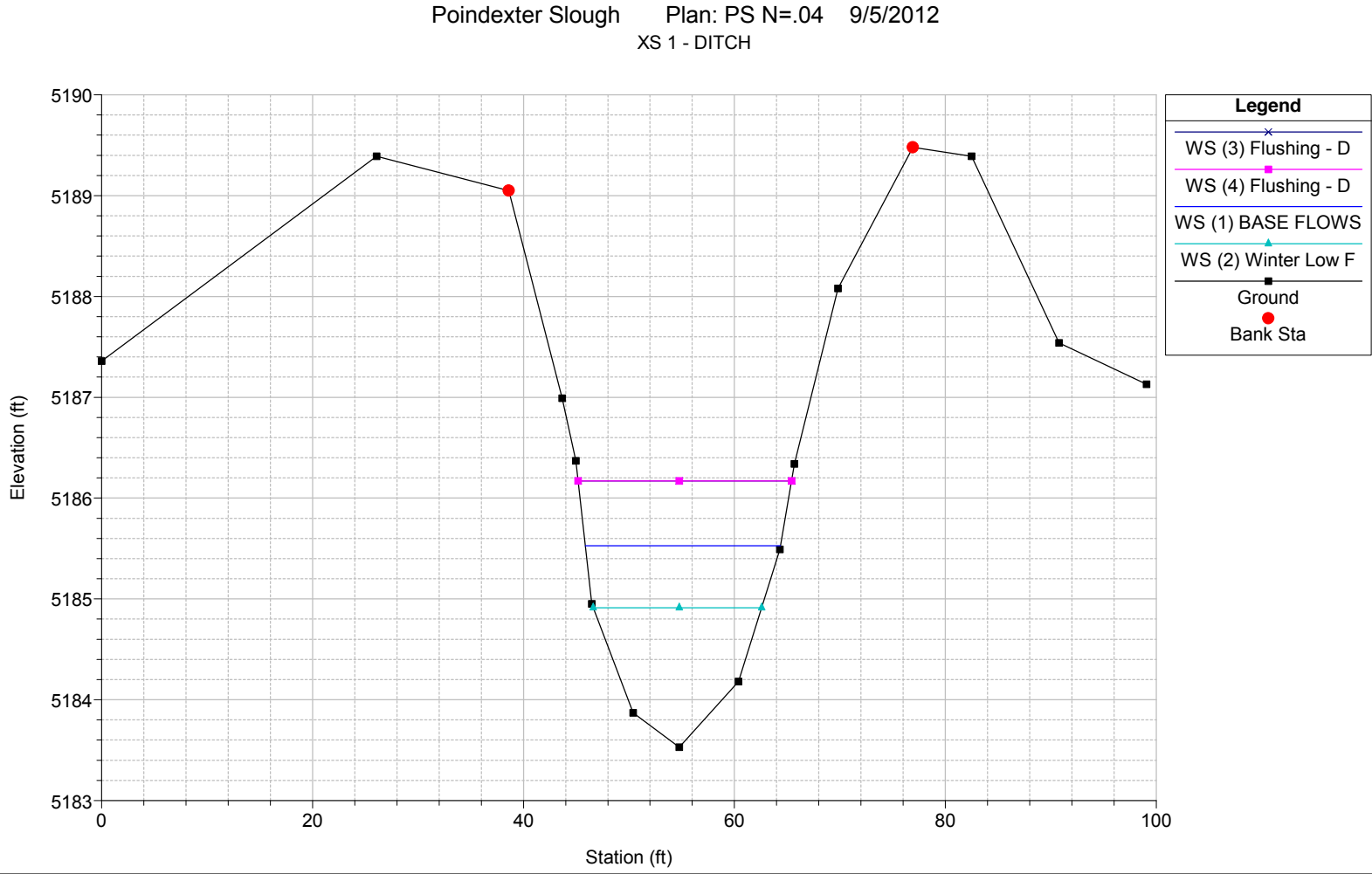
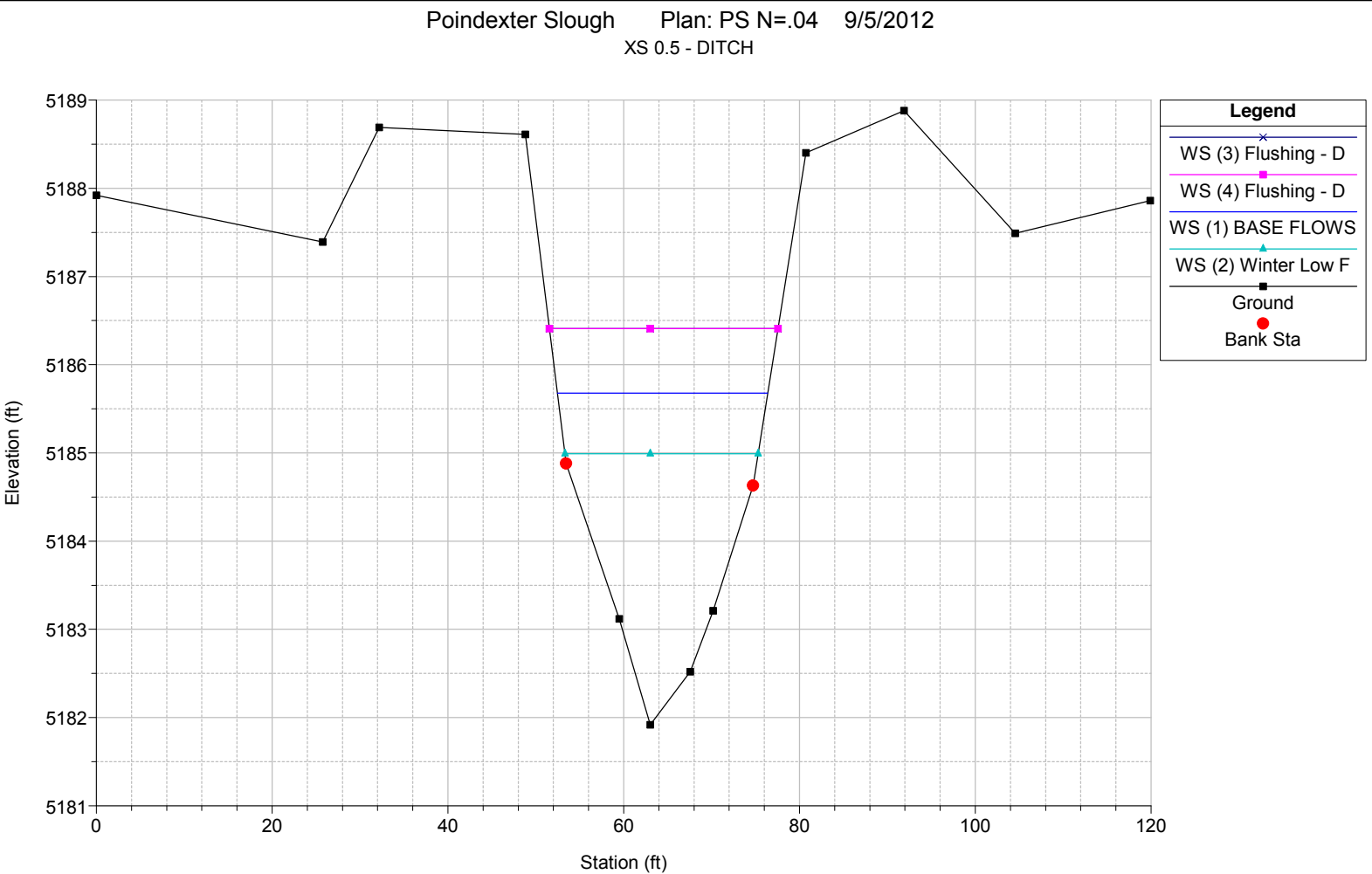
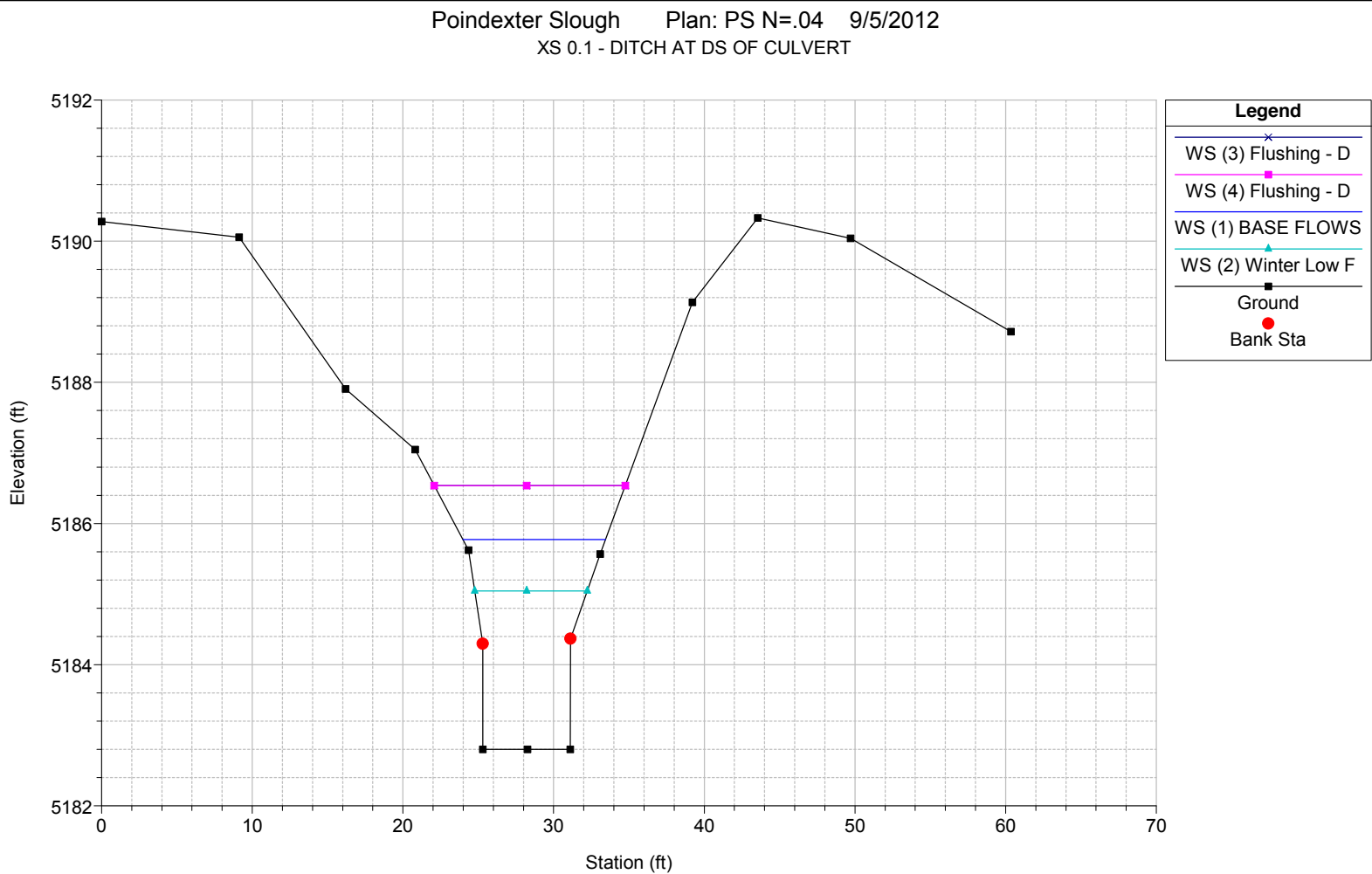
DRAWN RLB	CHECKED JL	APPROVED JL
DATE: March 8, 2010		
FILE: poindexter xs.dwg		

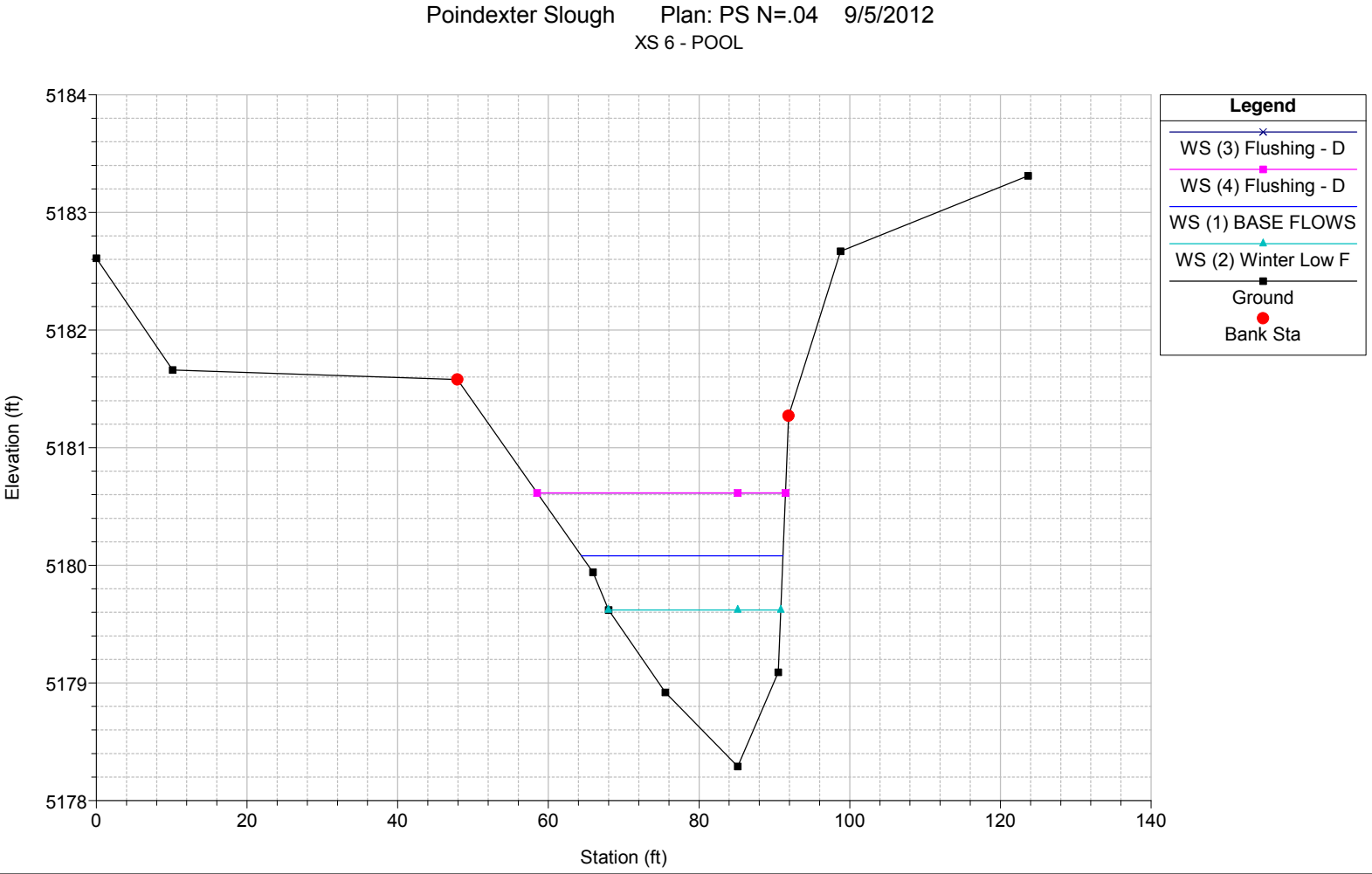
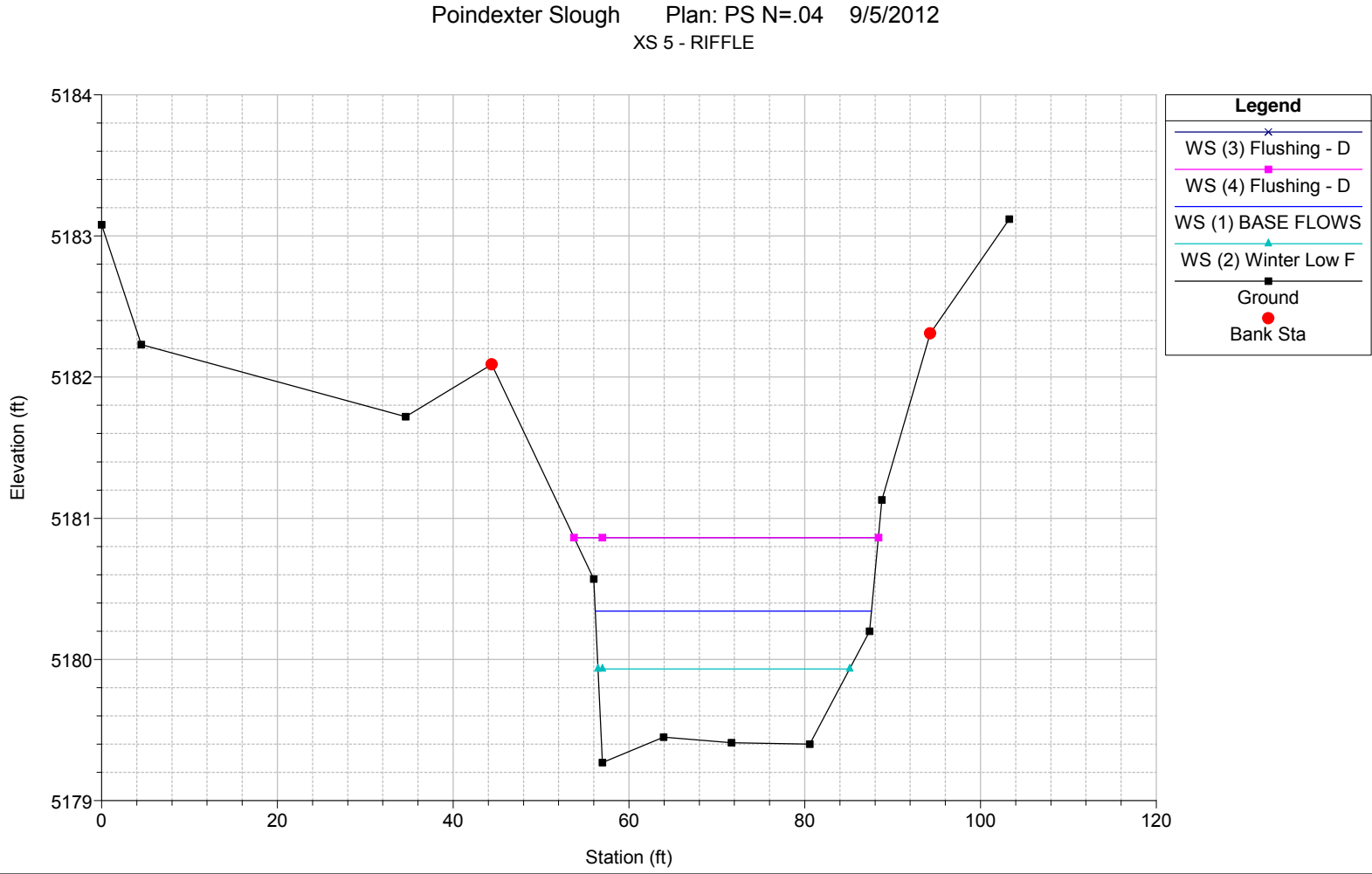
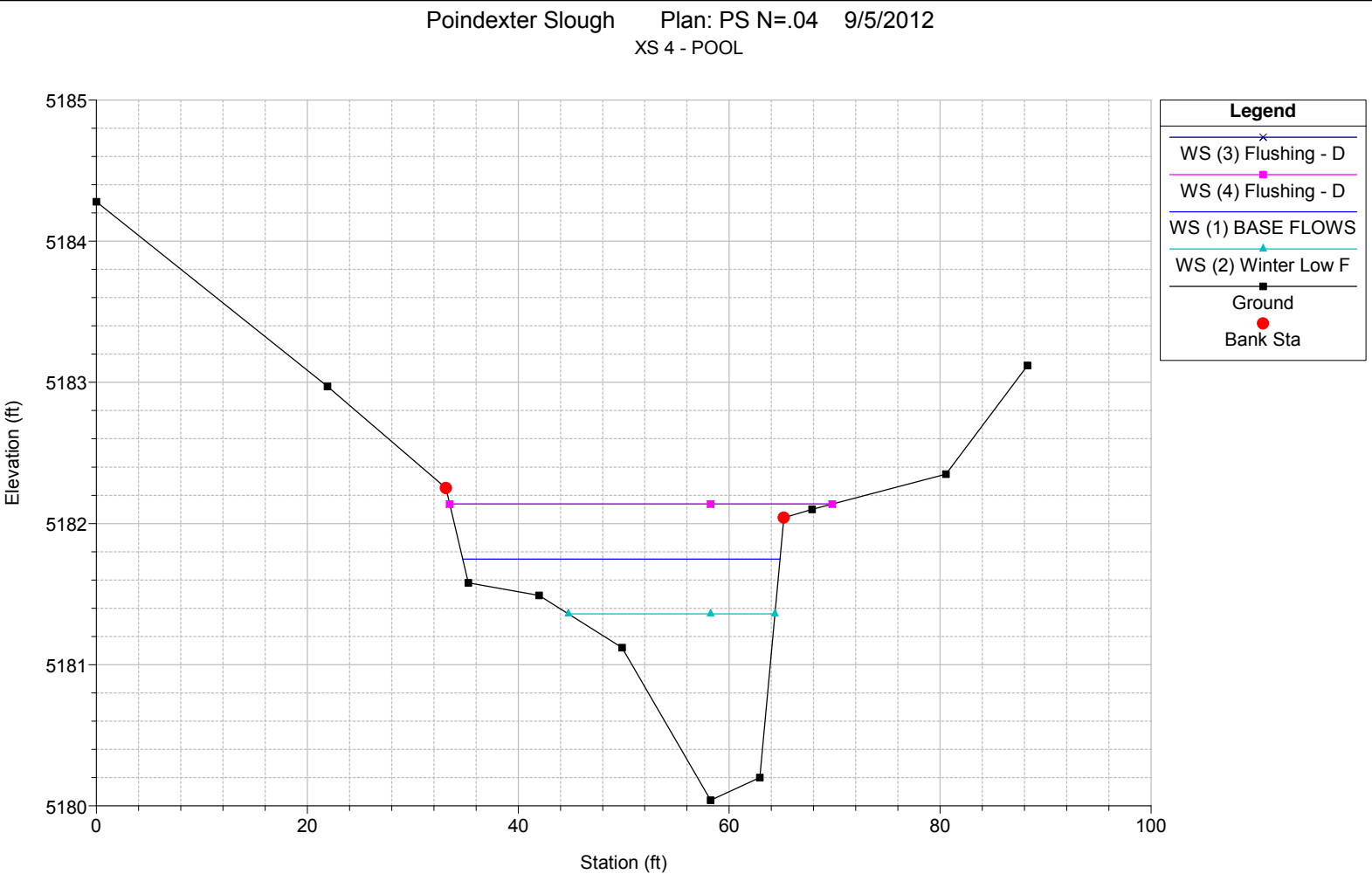
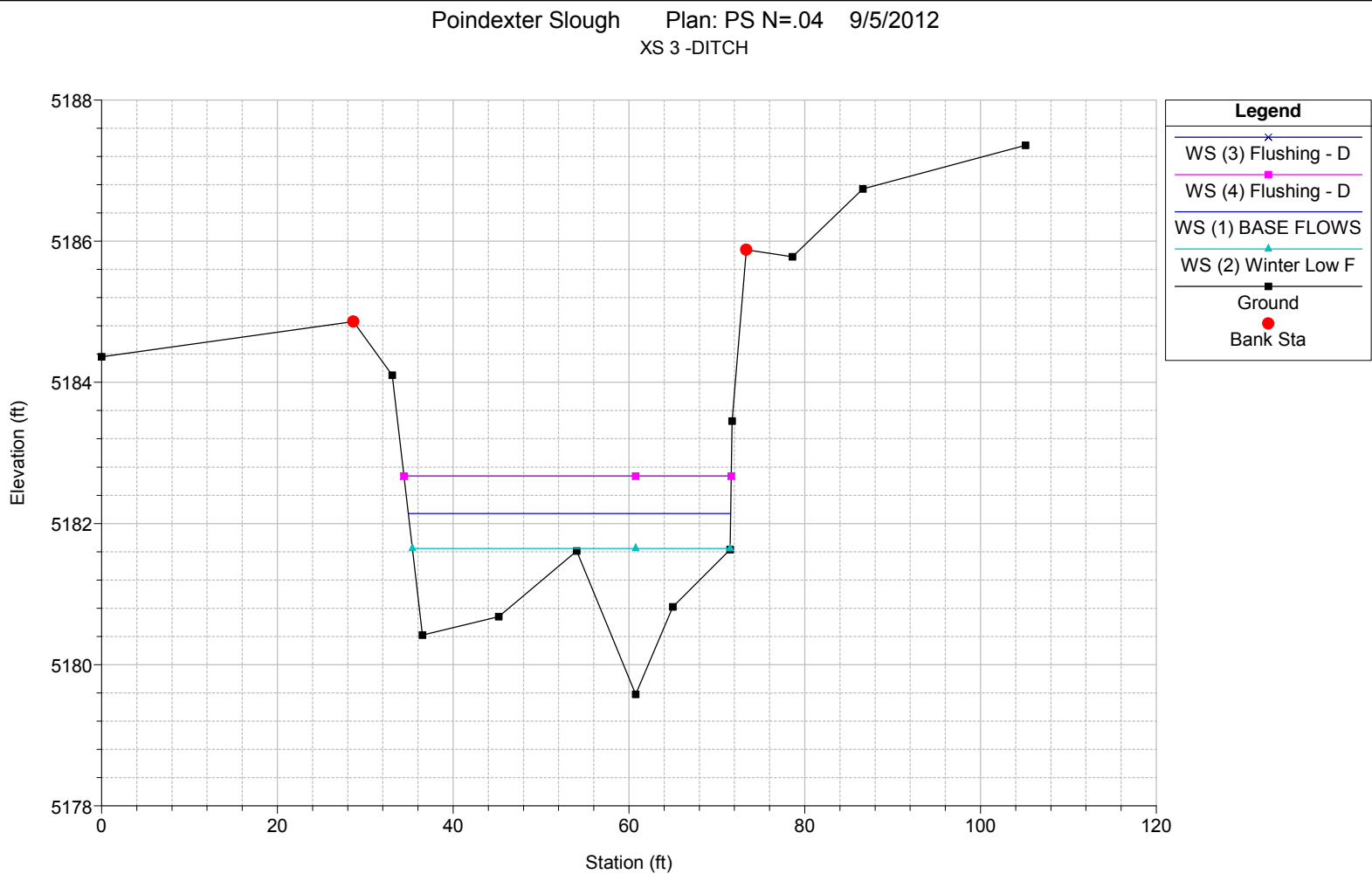


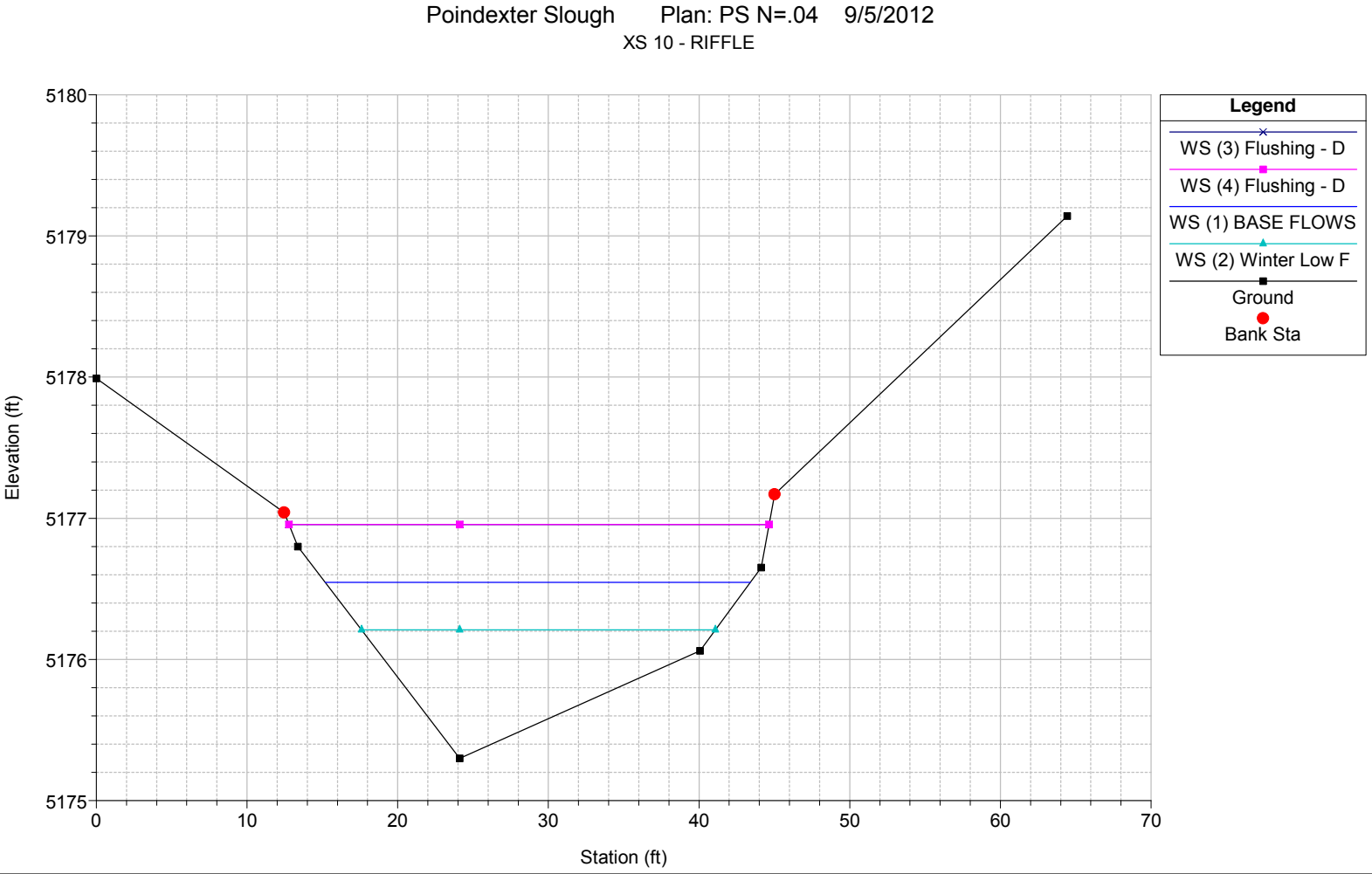
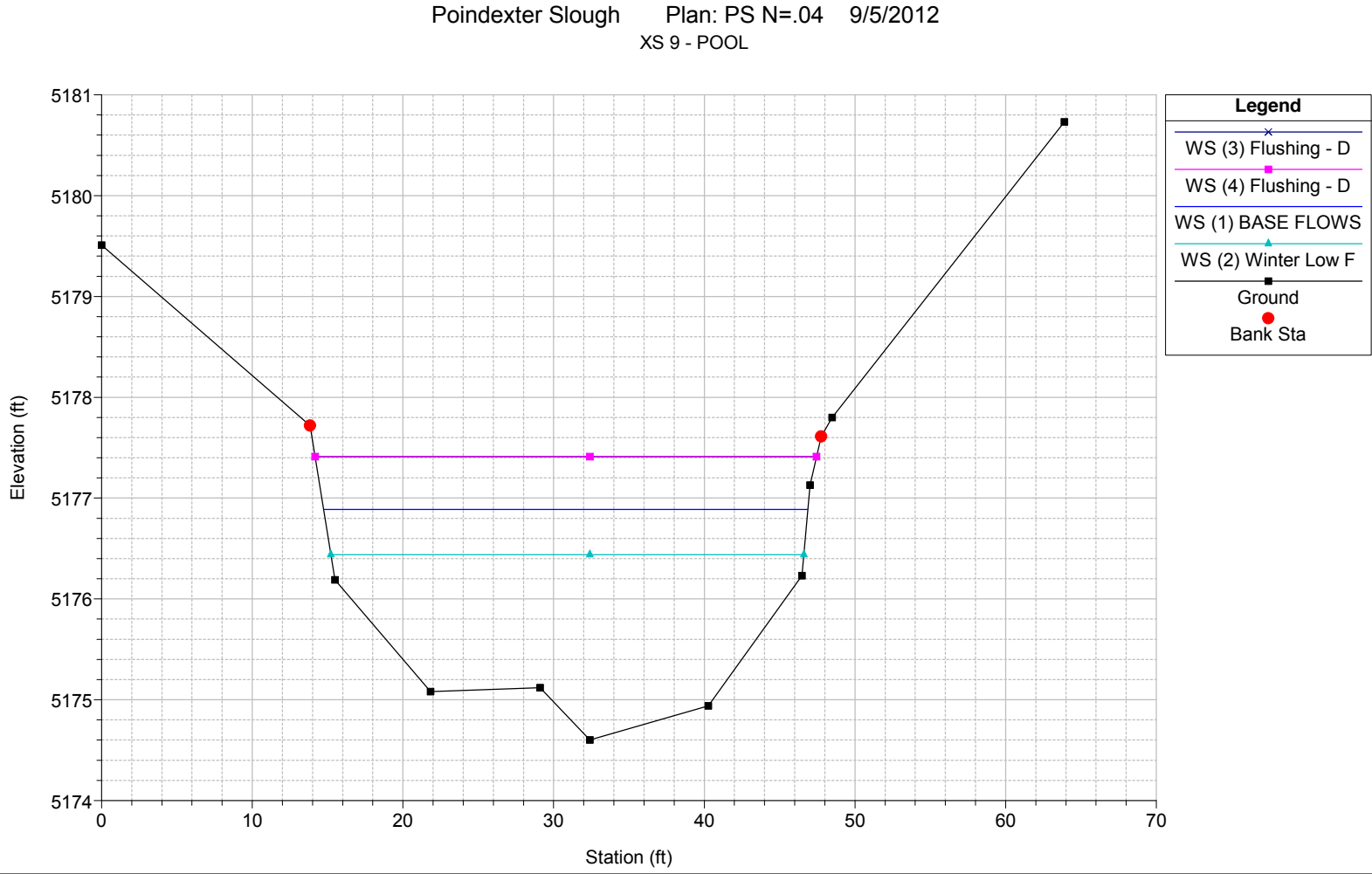
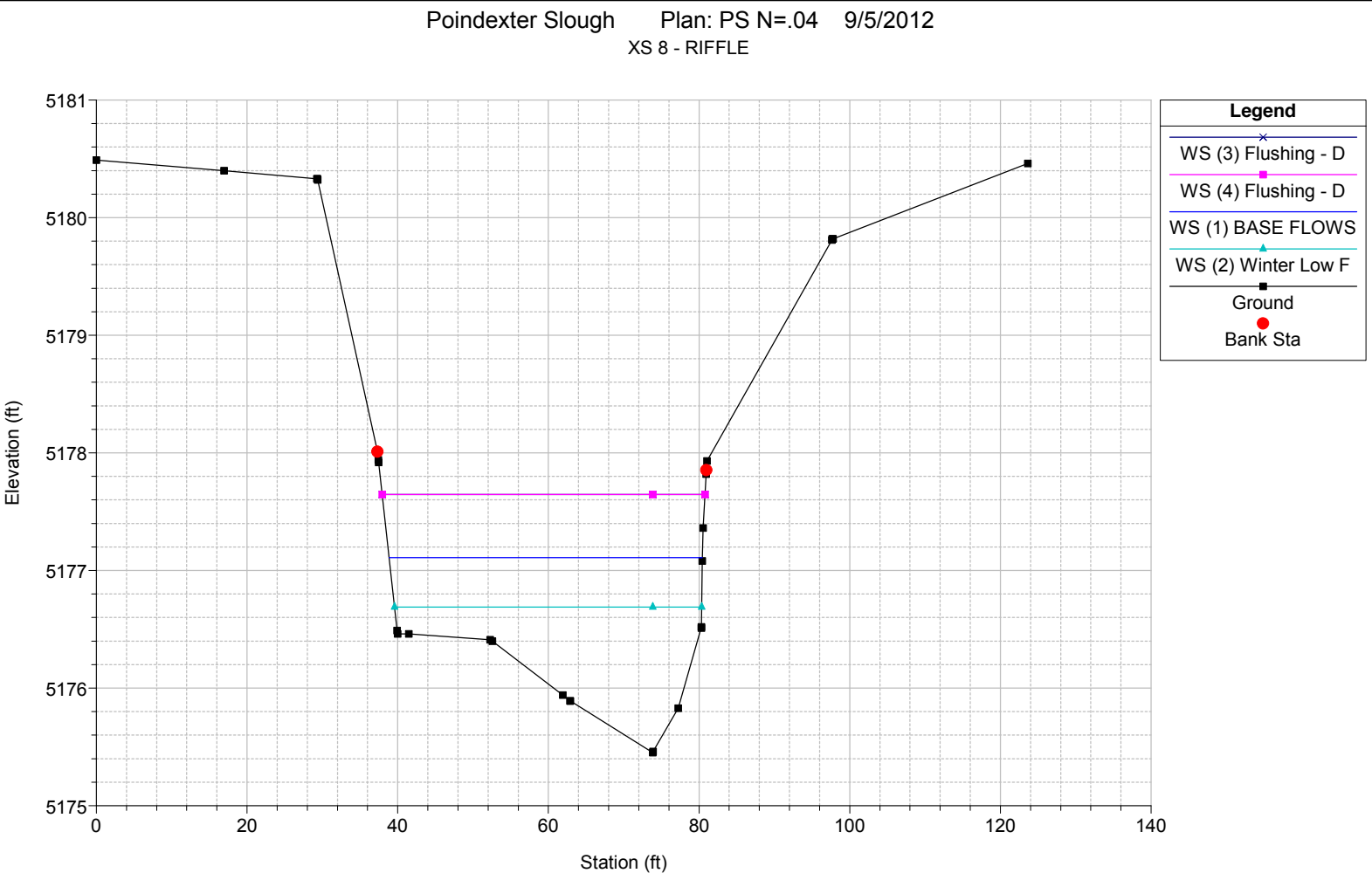
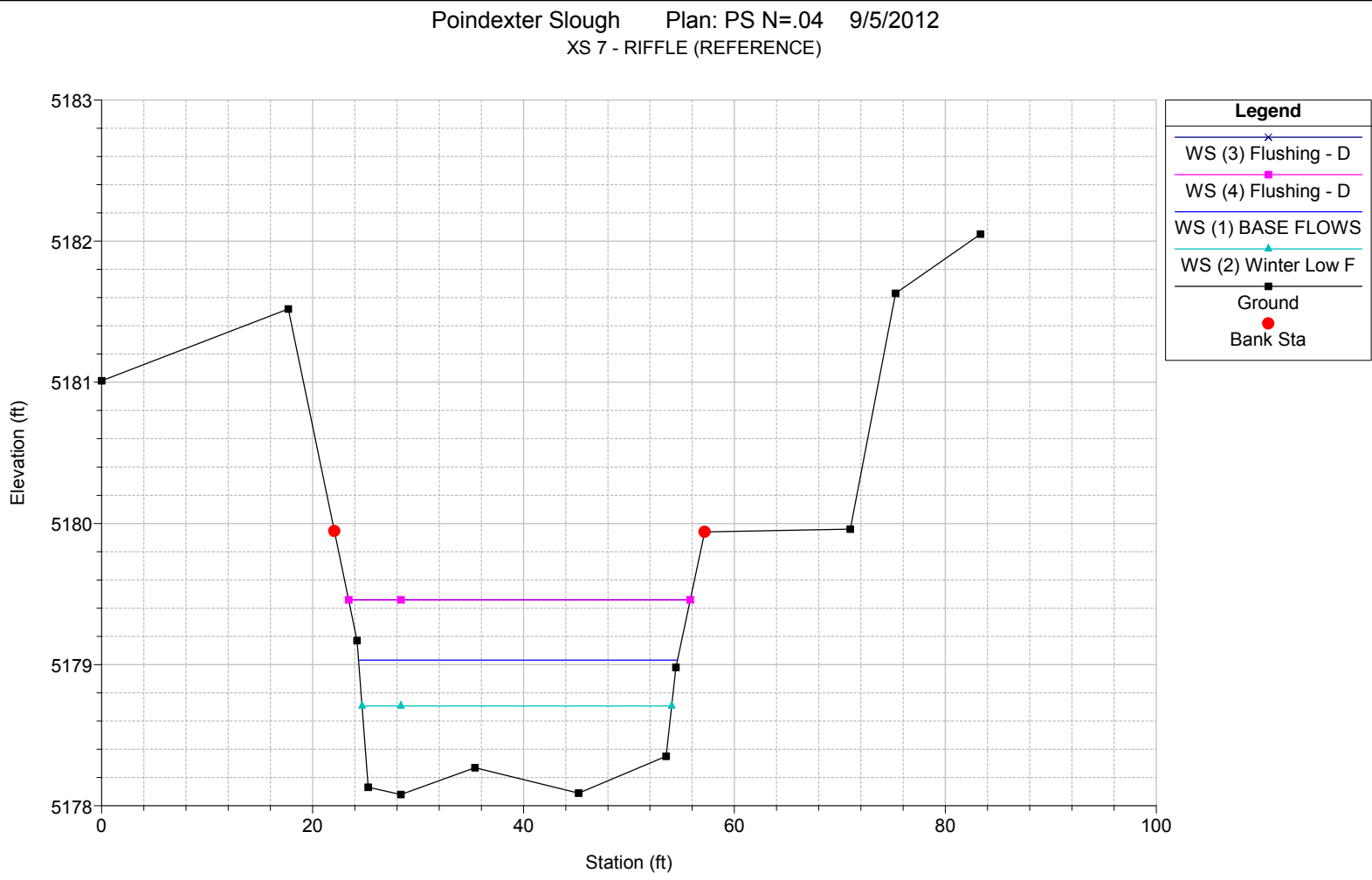
Appendix C

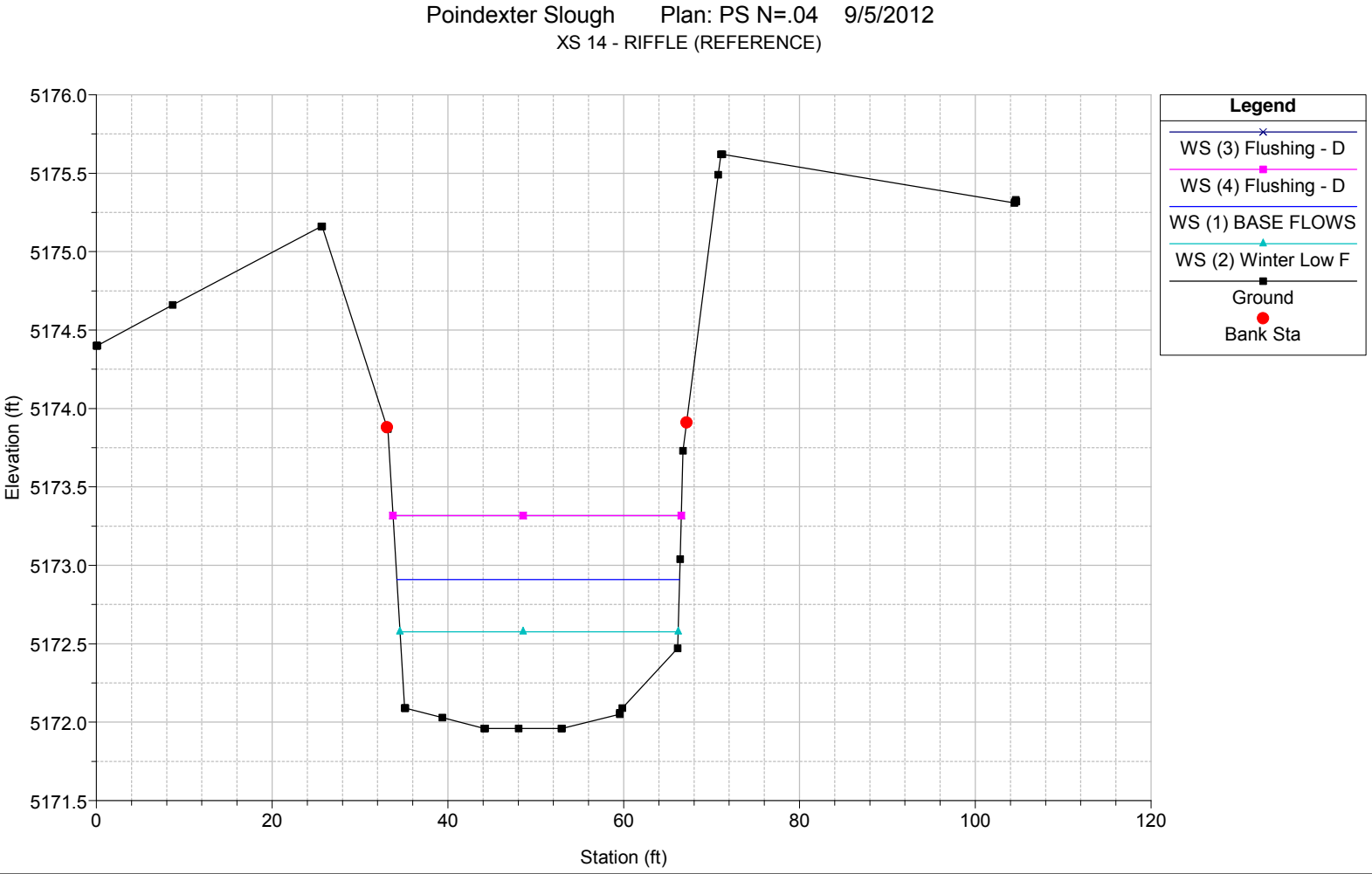
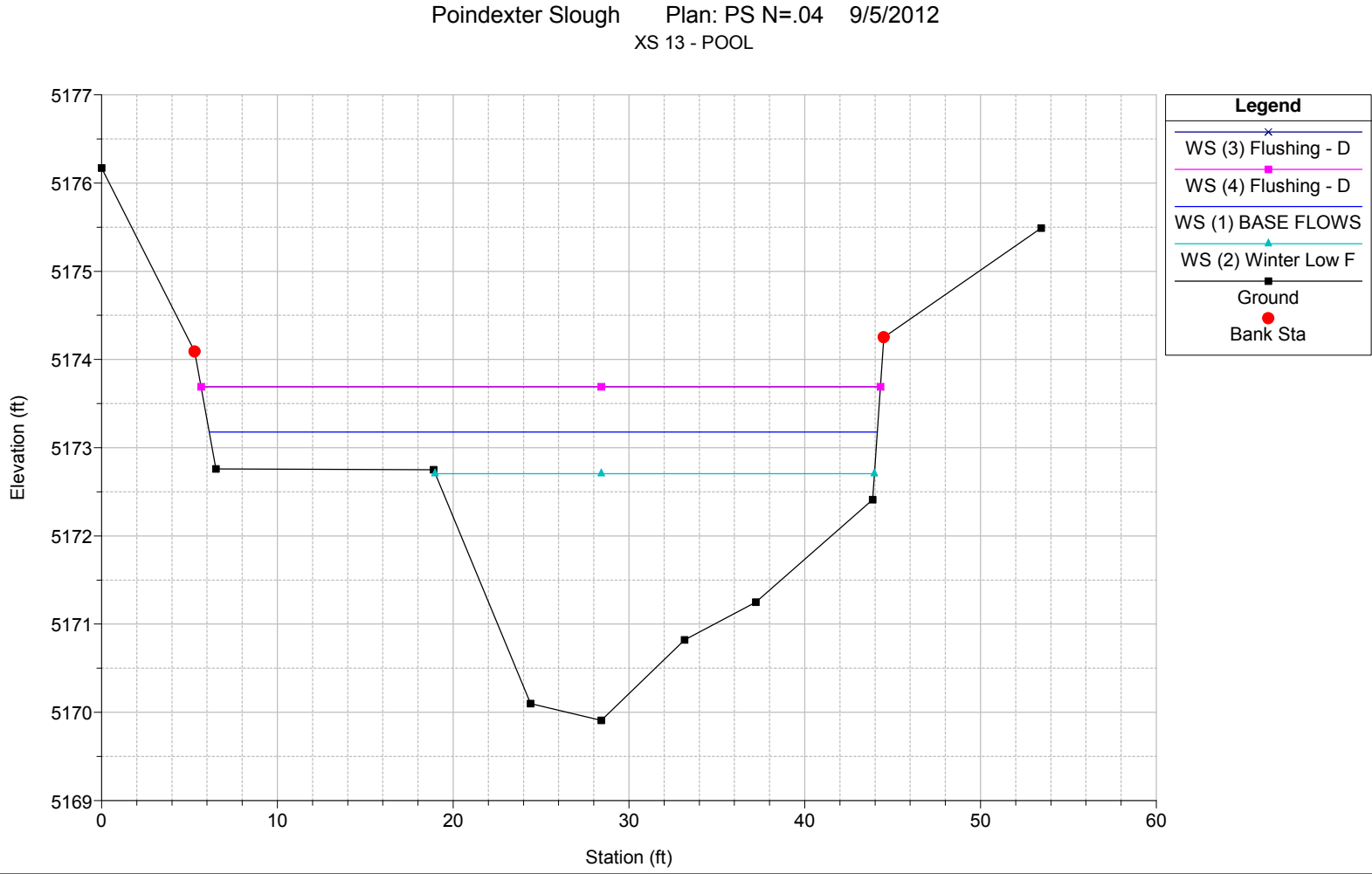
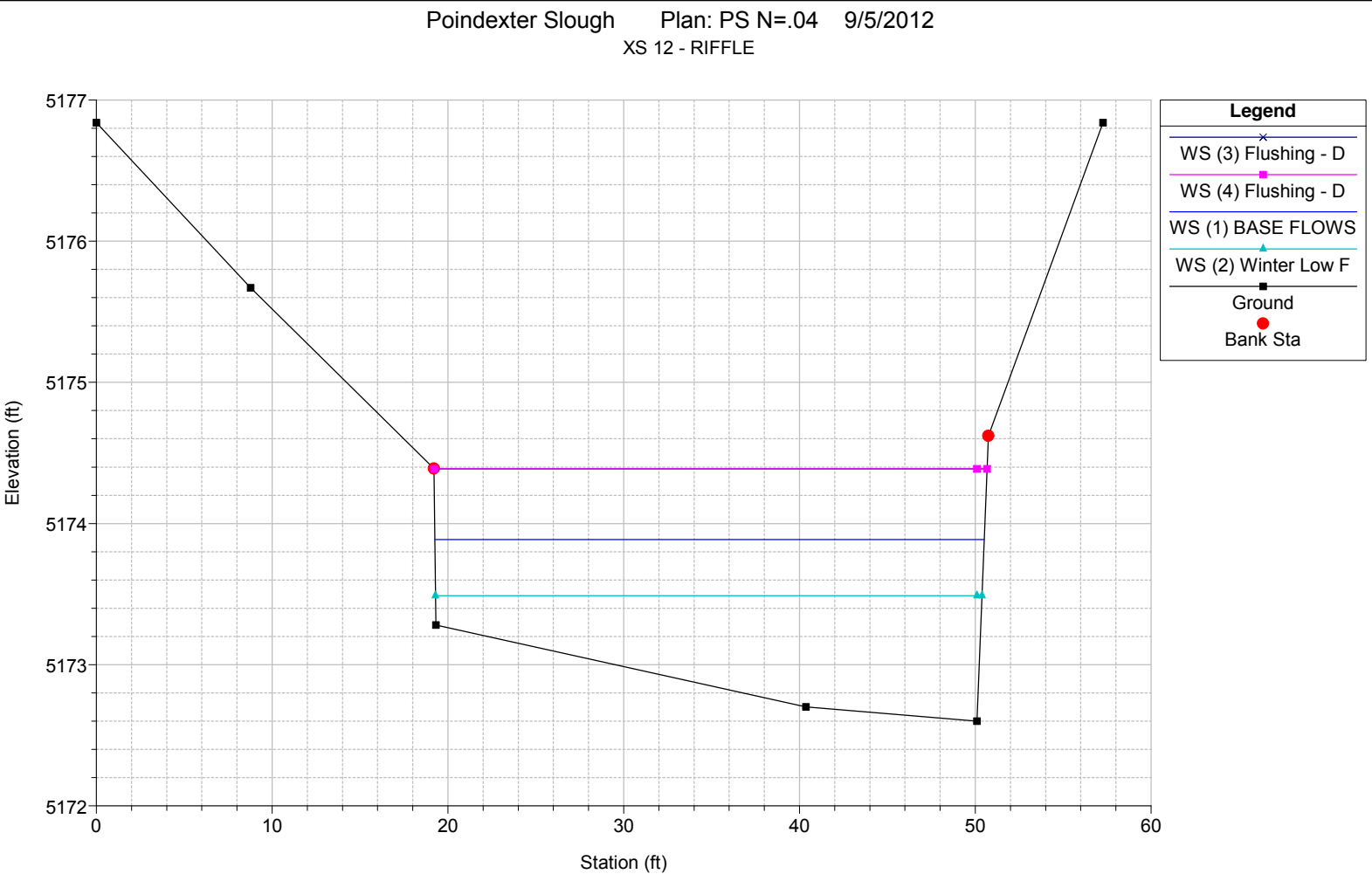
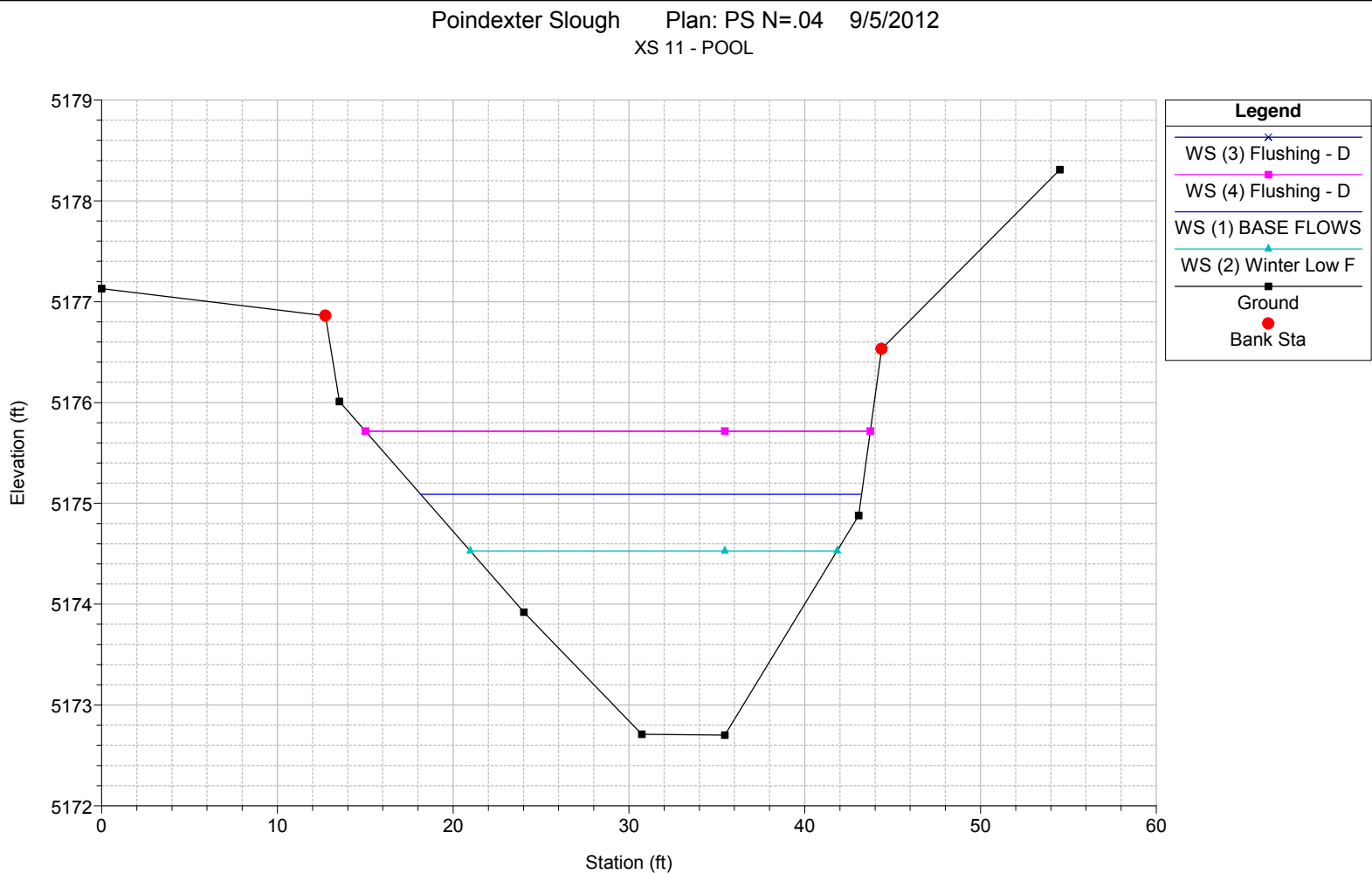
Hec-Ras Profile, Hydraulic Results and Cross Sections

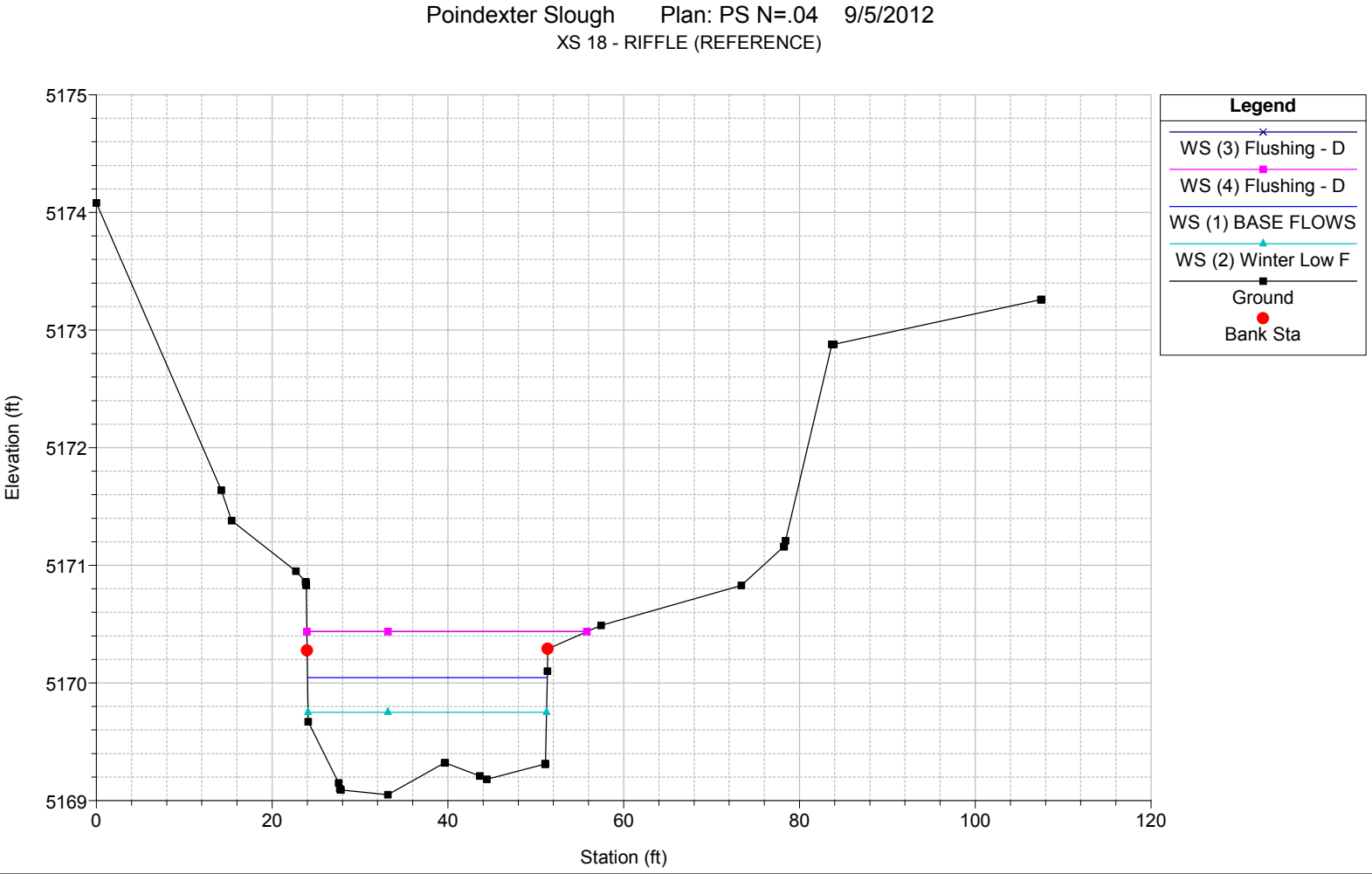
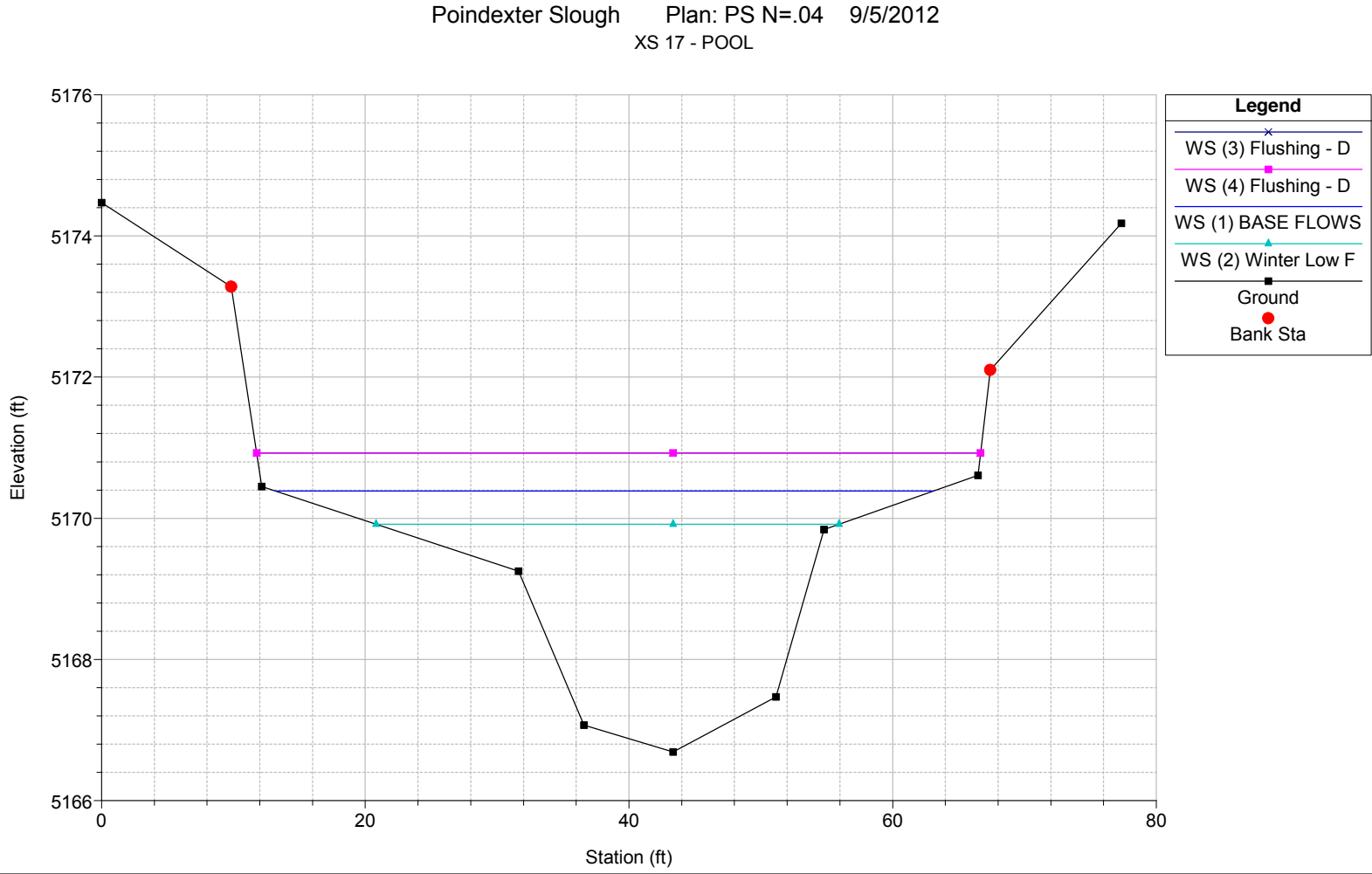
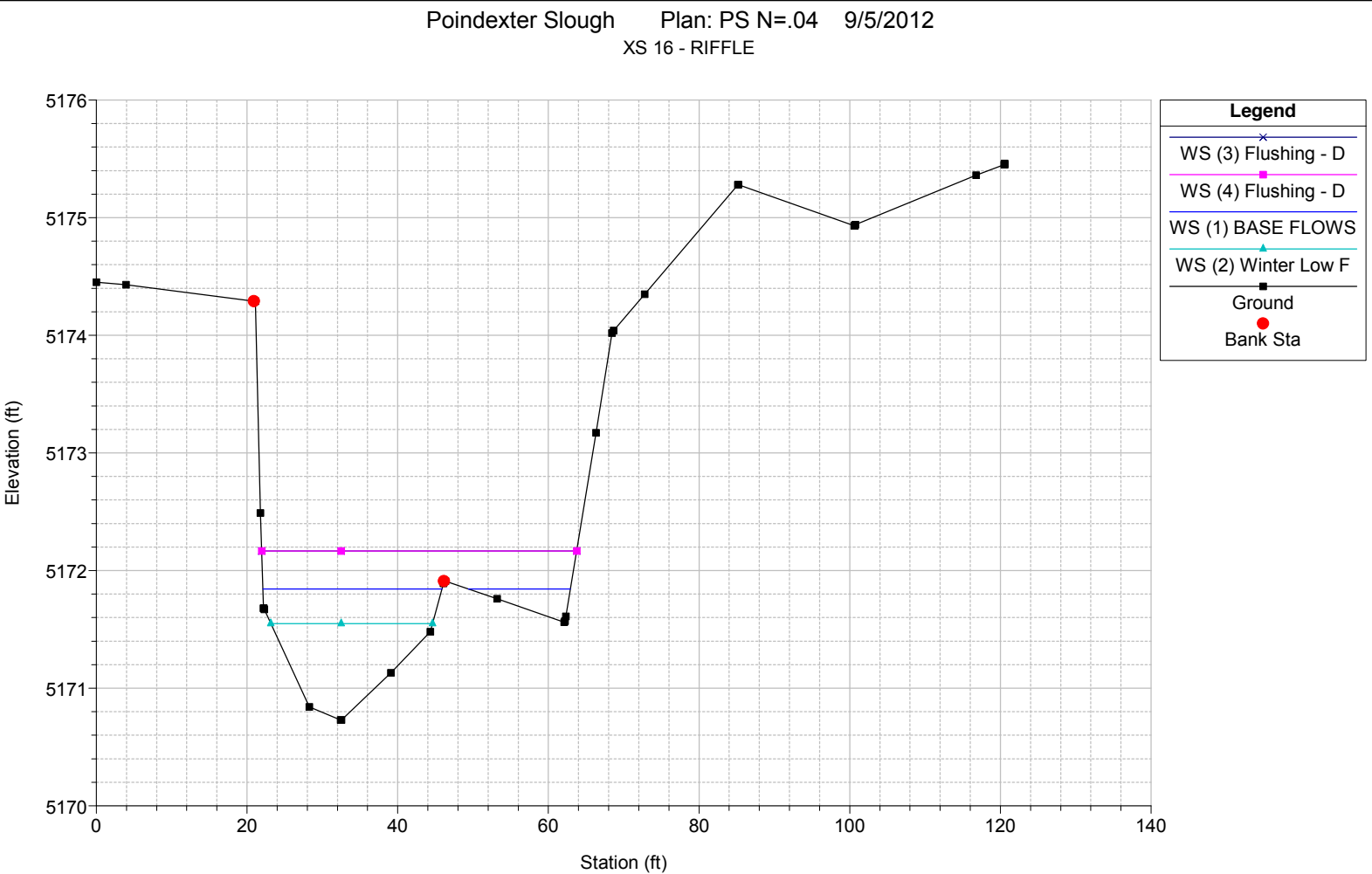
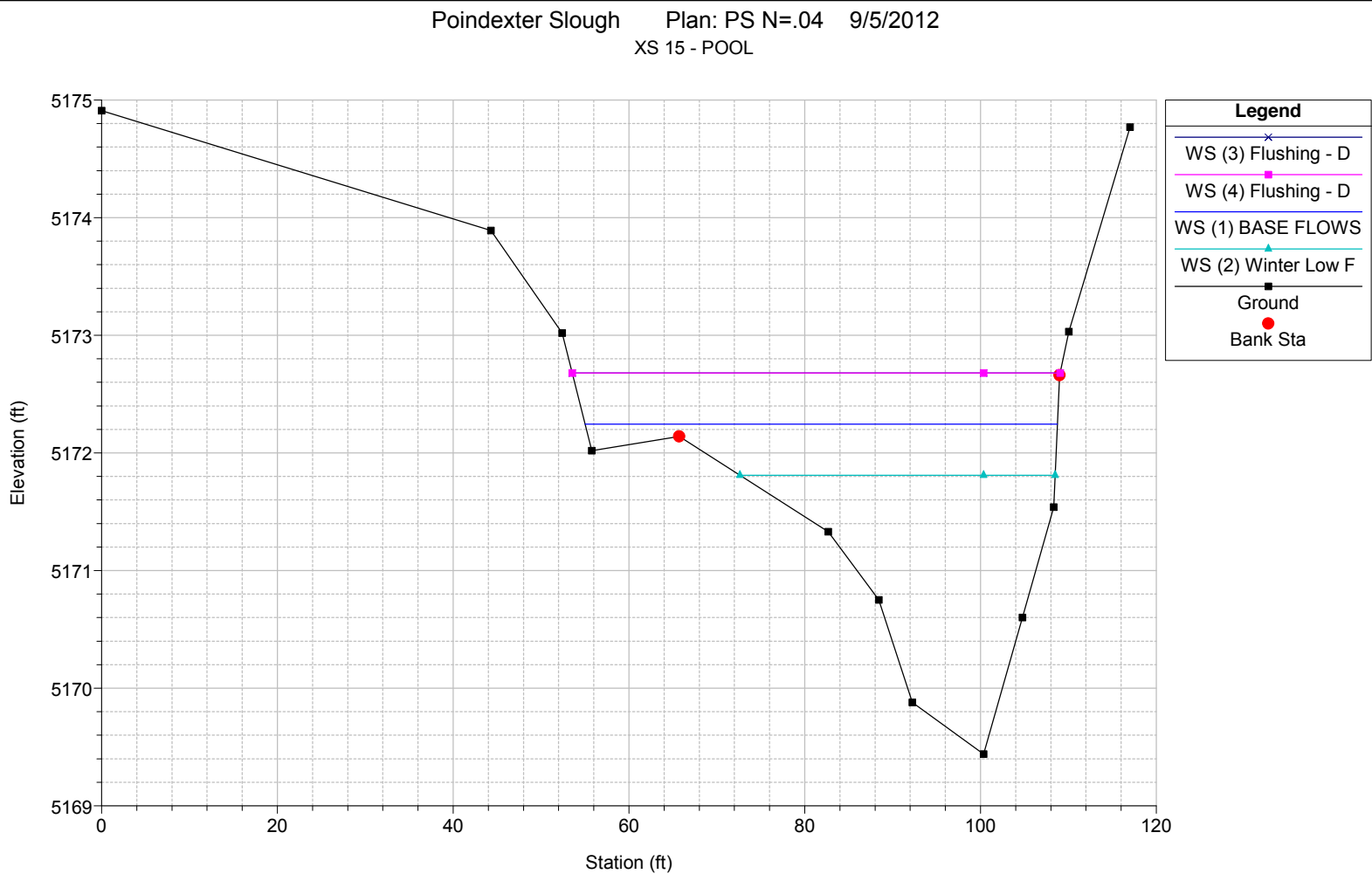


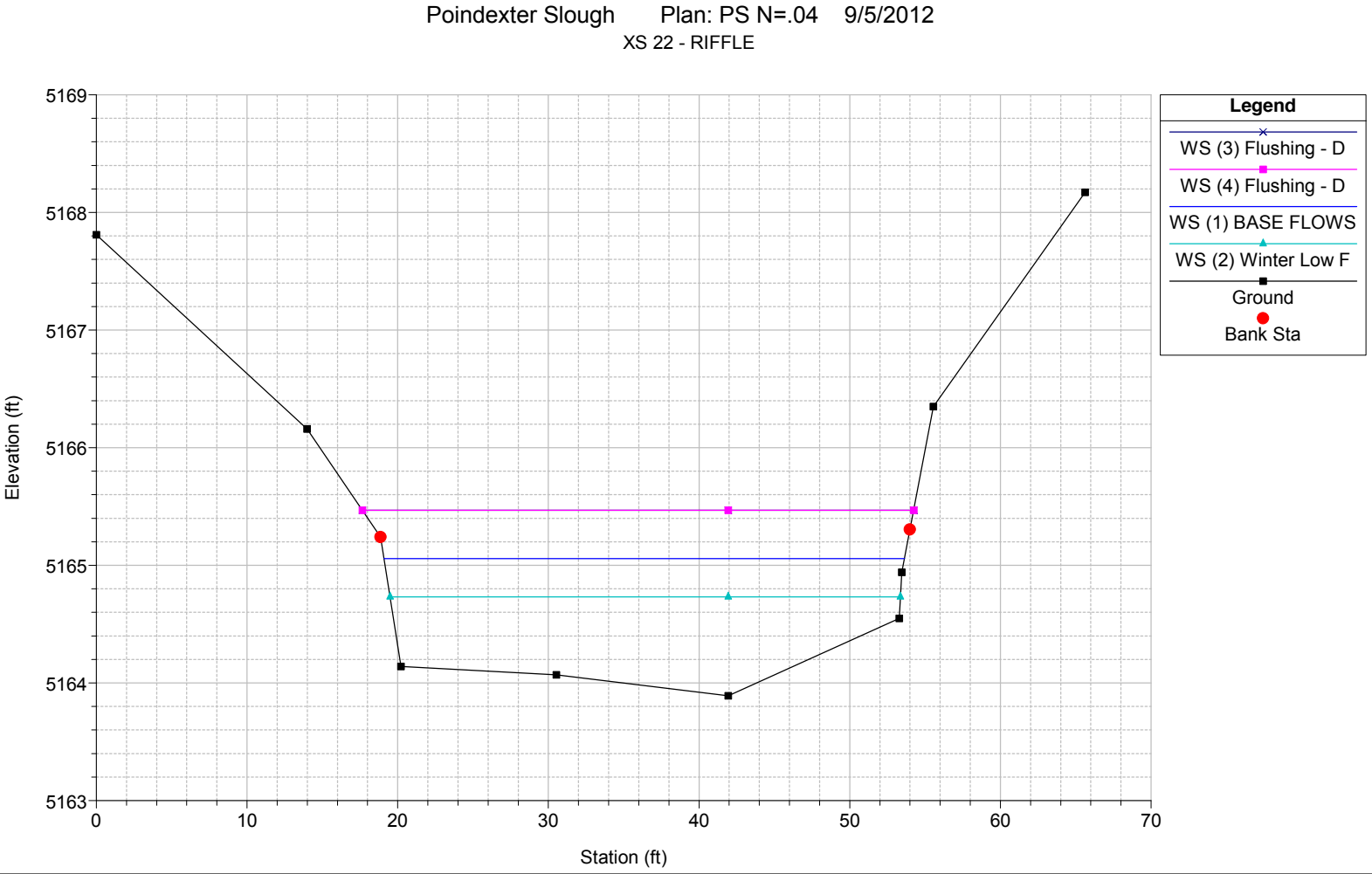
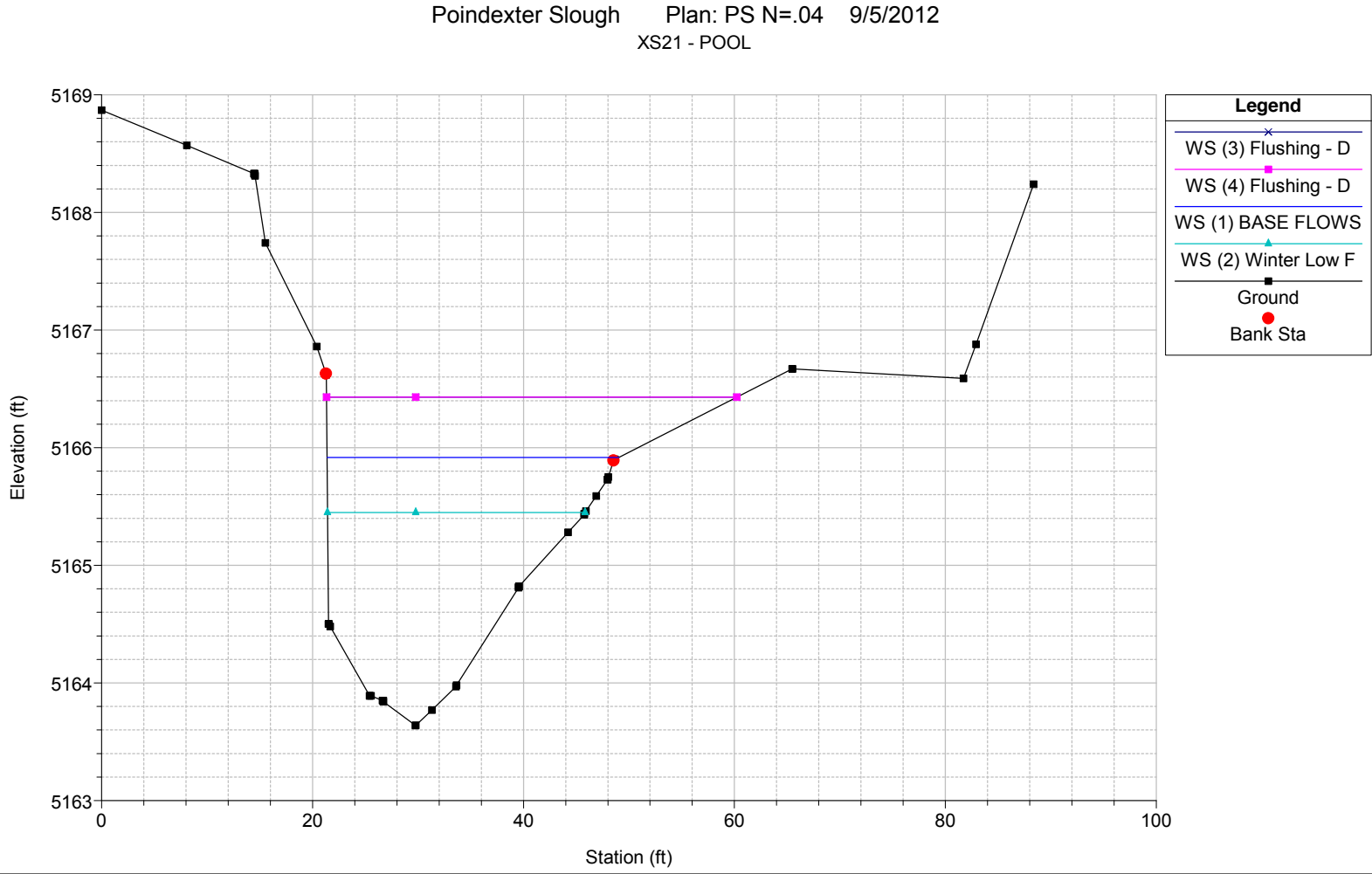
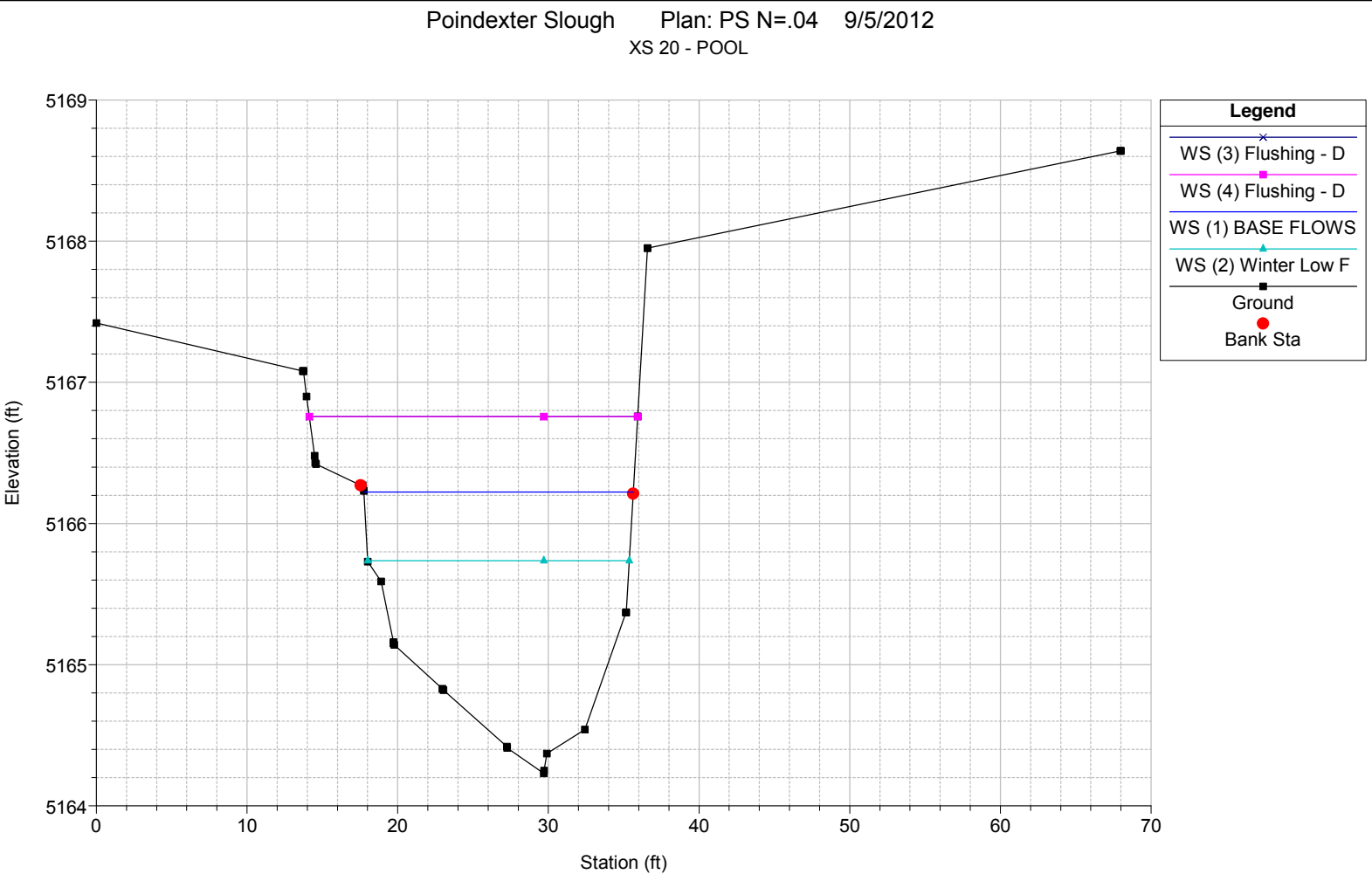
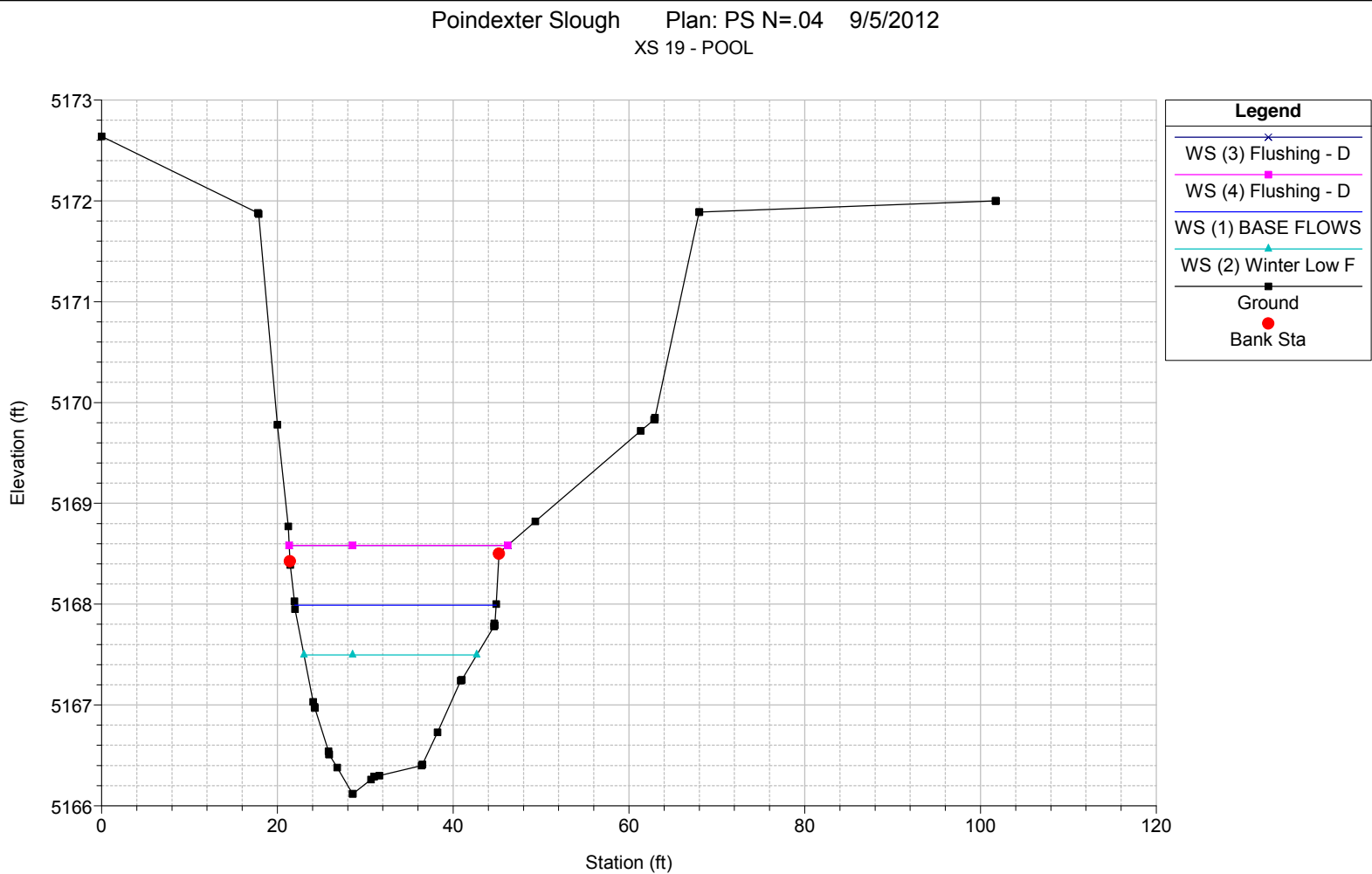


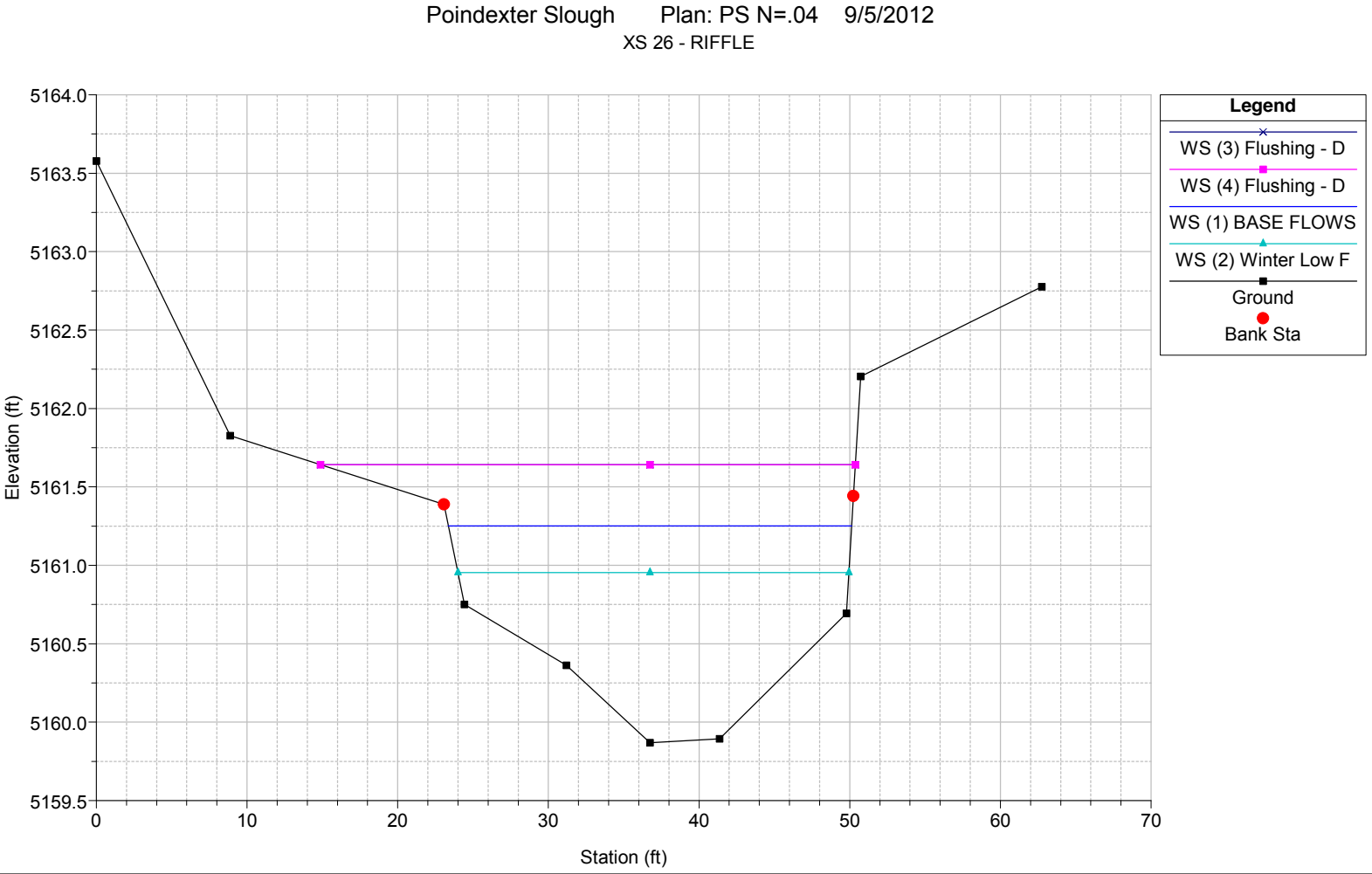
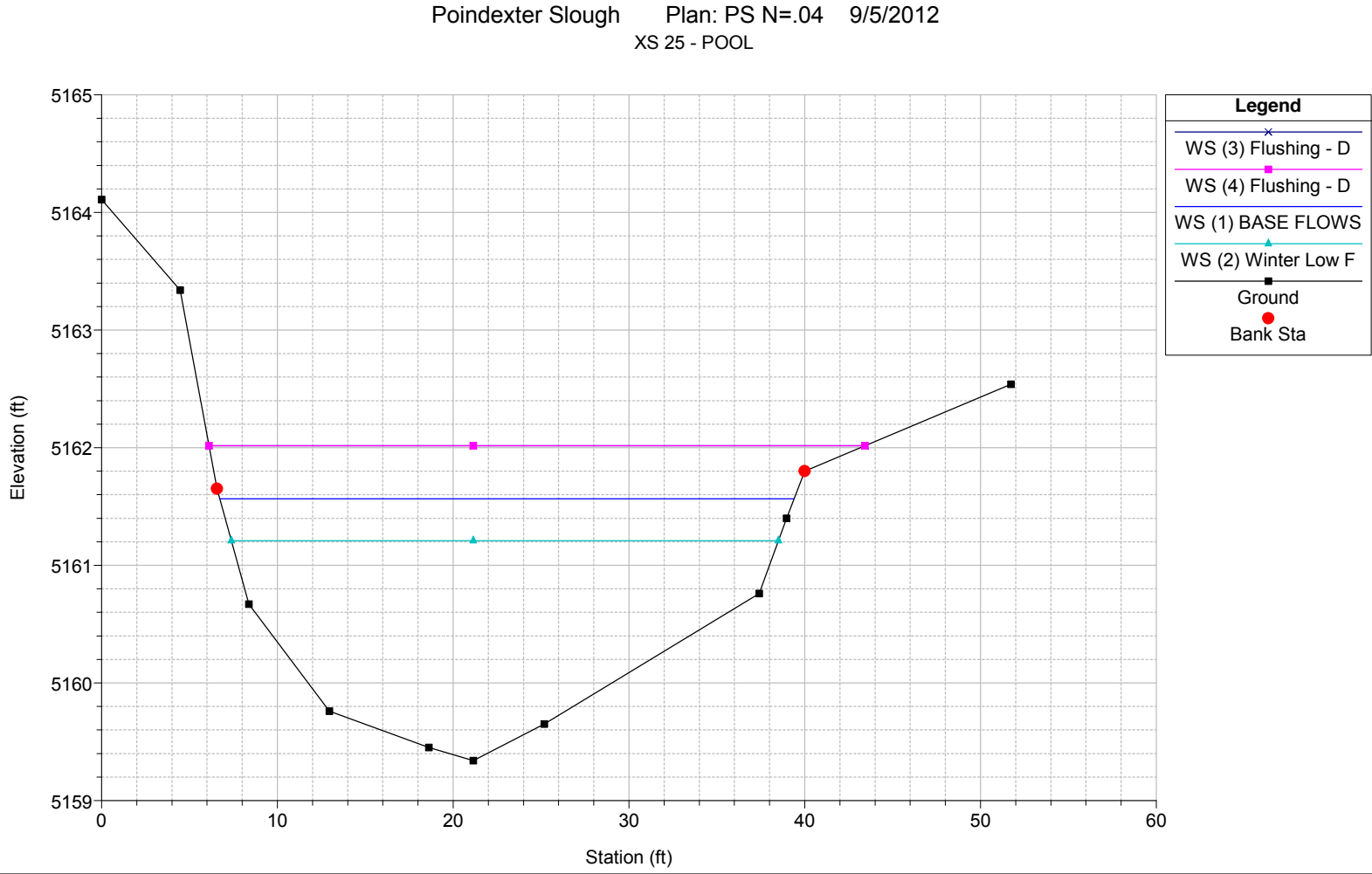
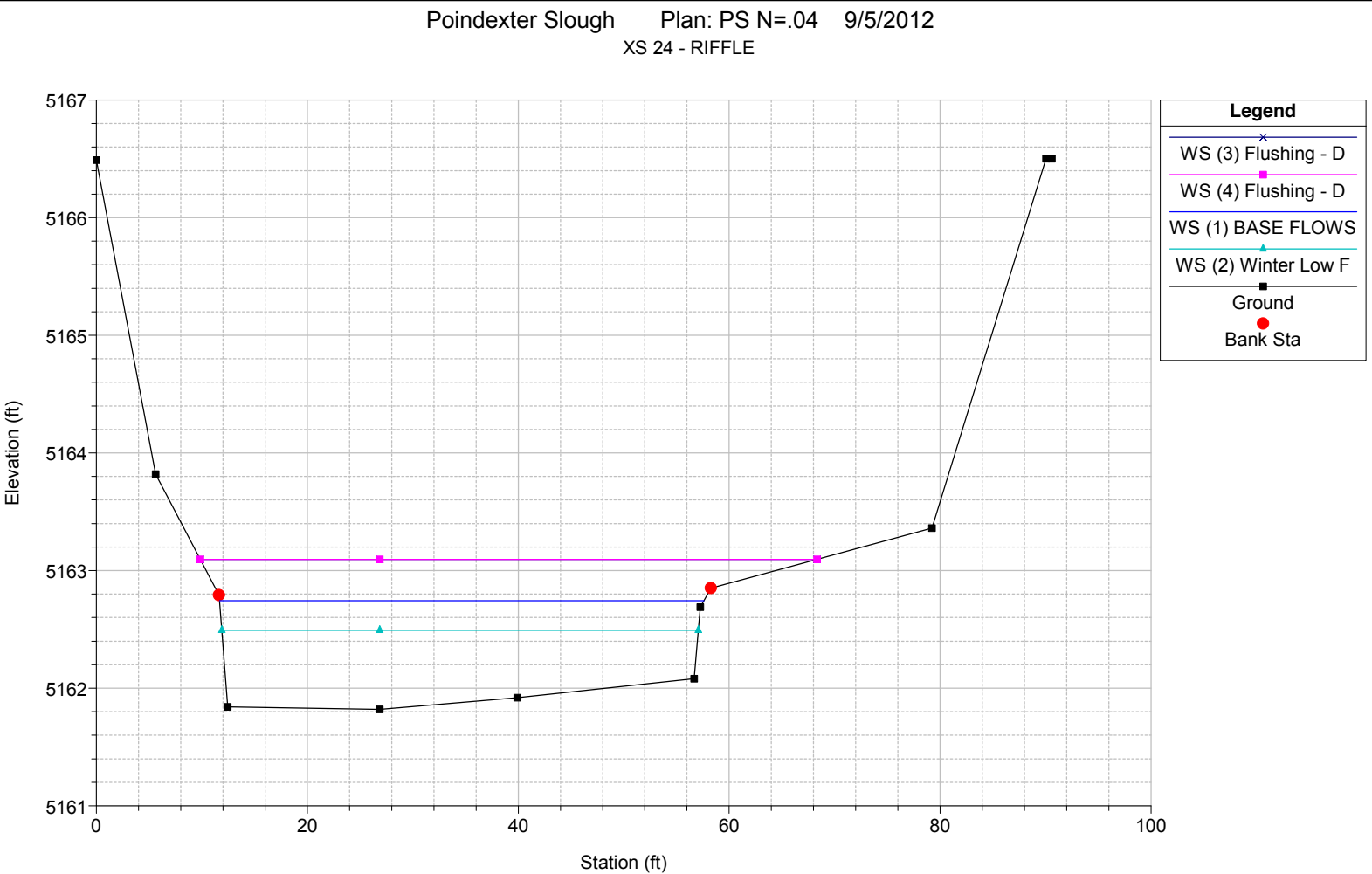
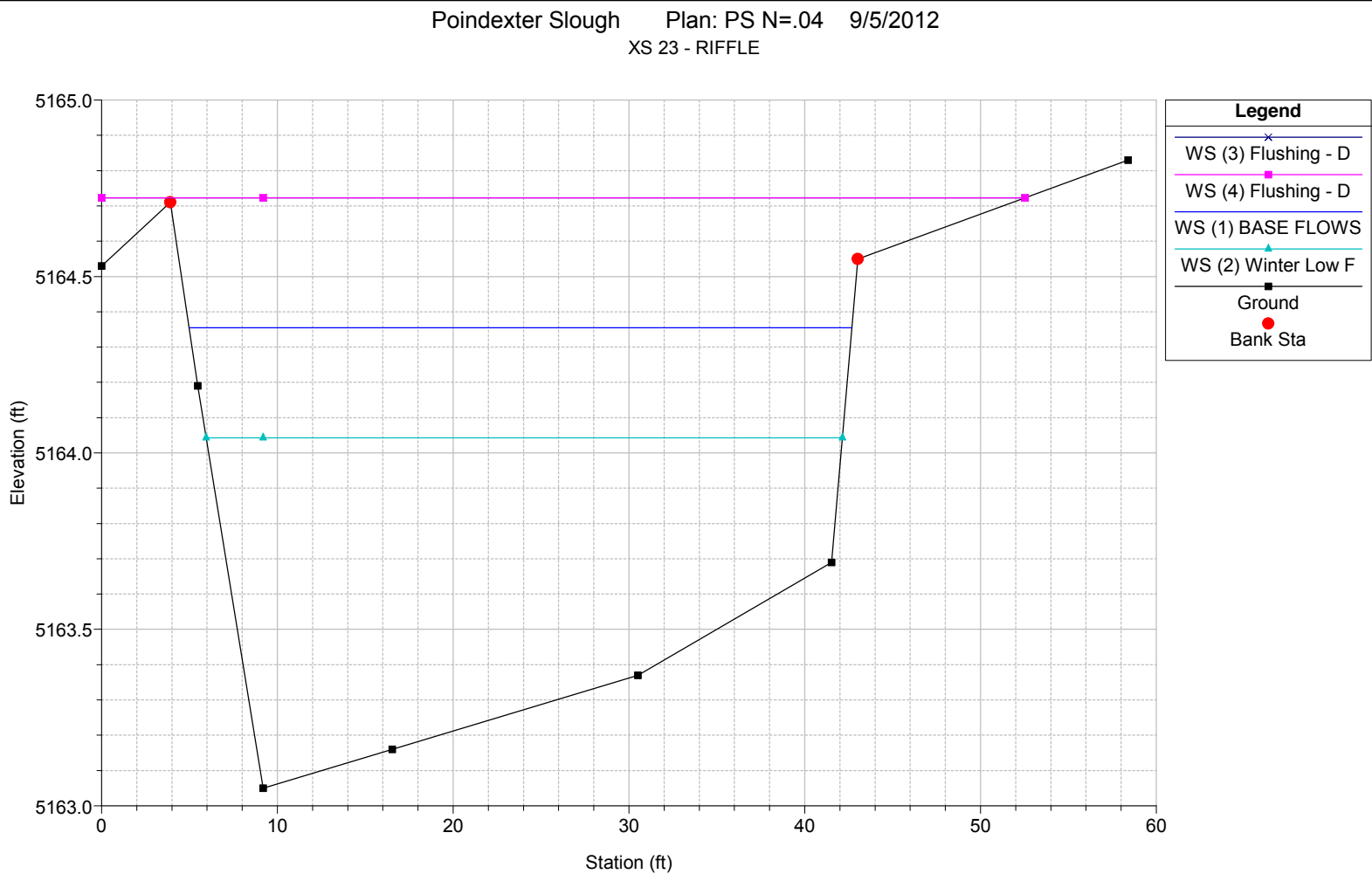


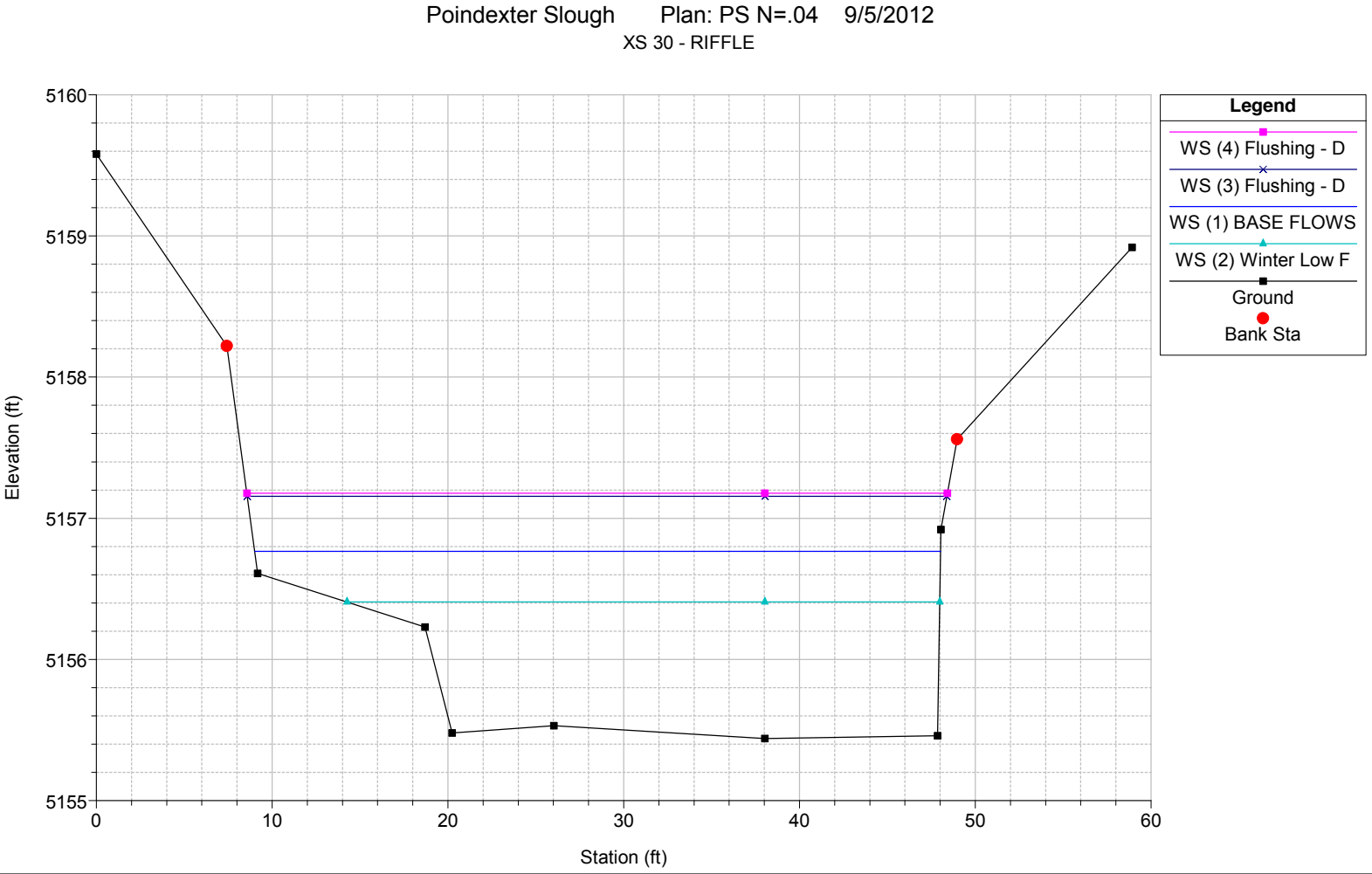
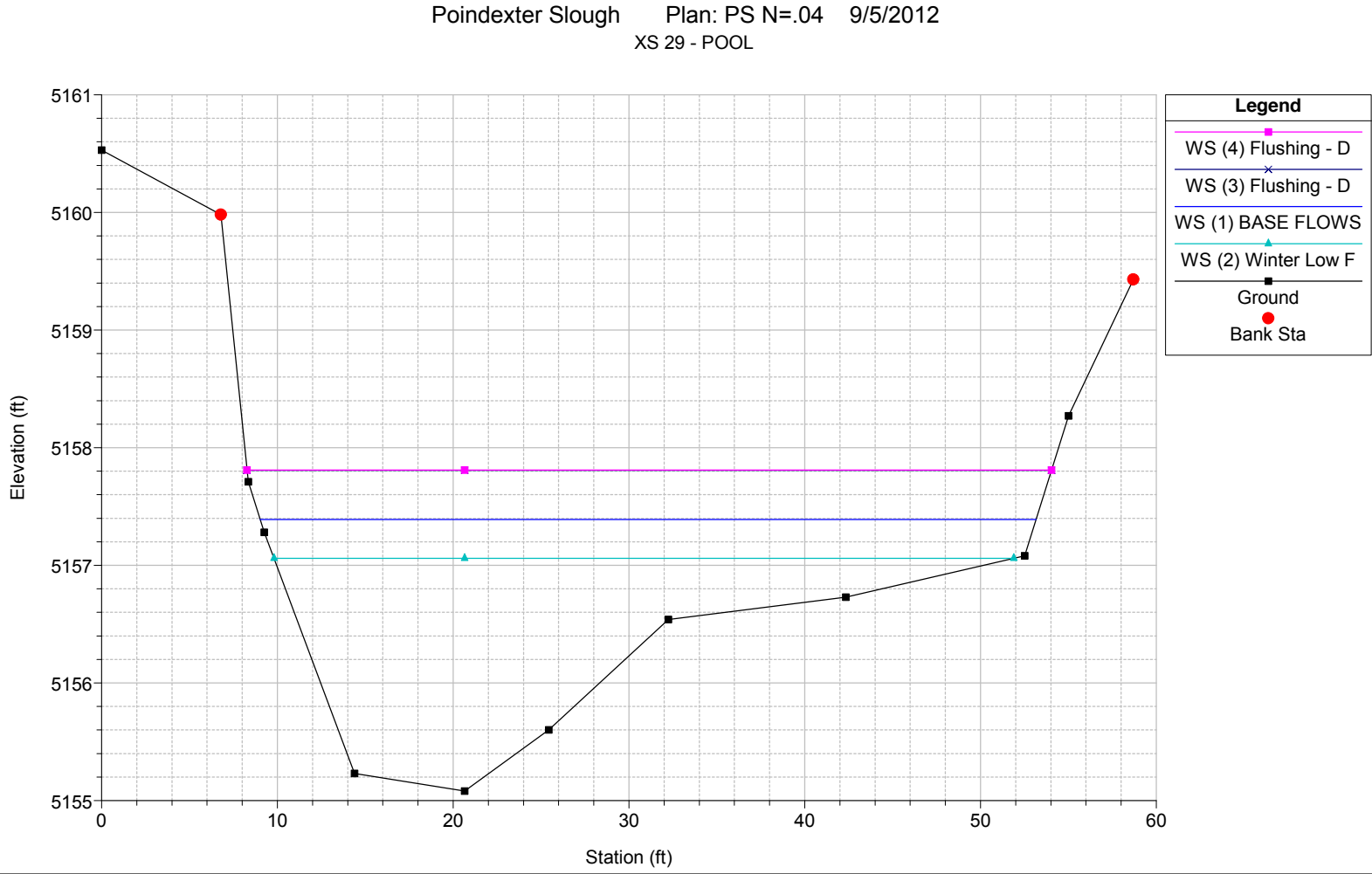
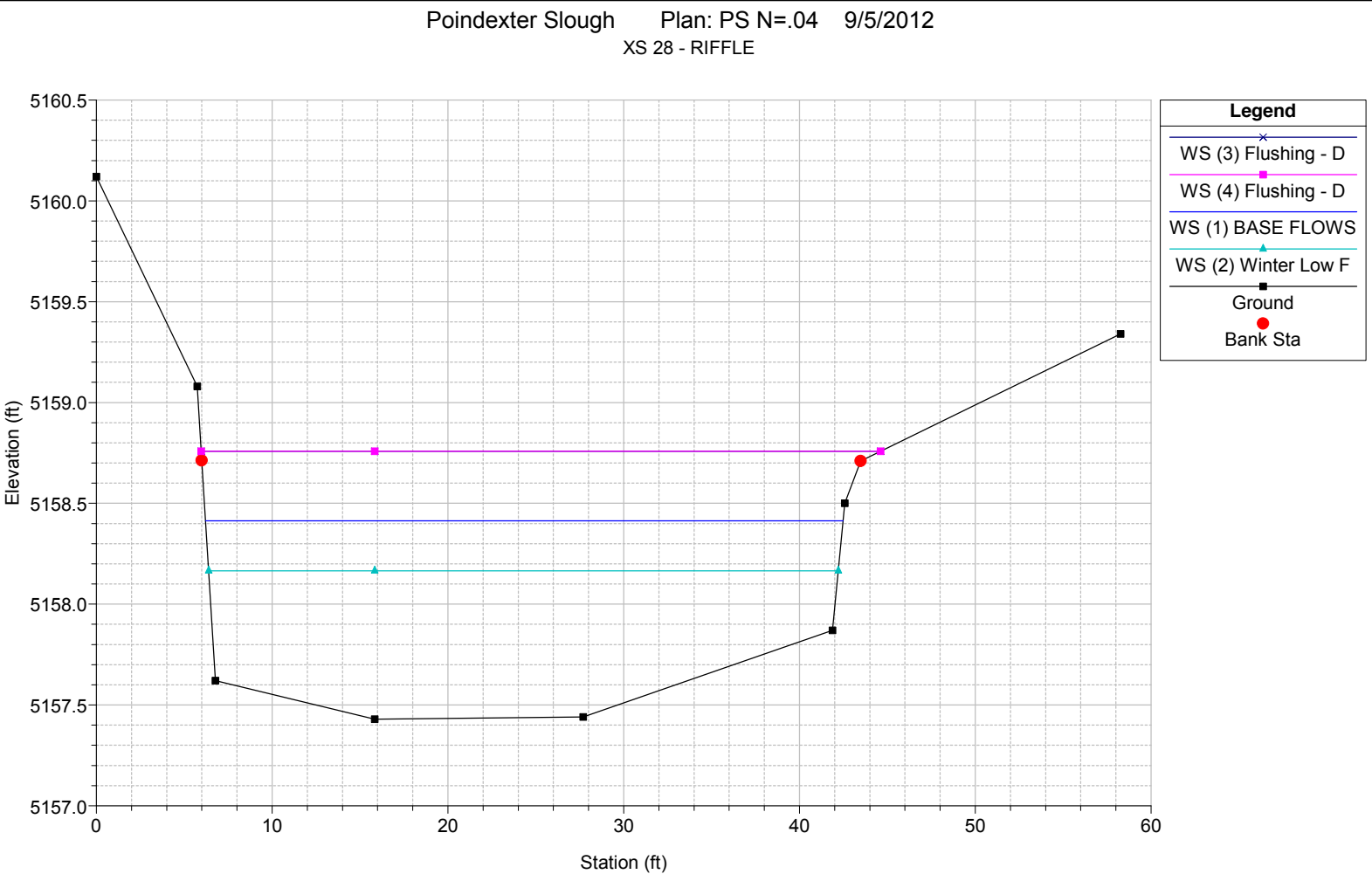
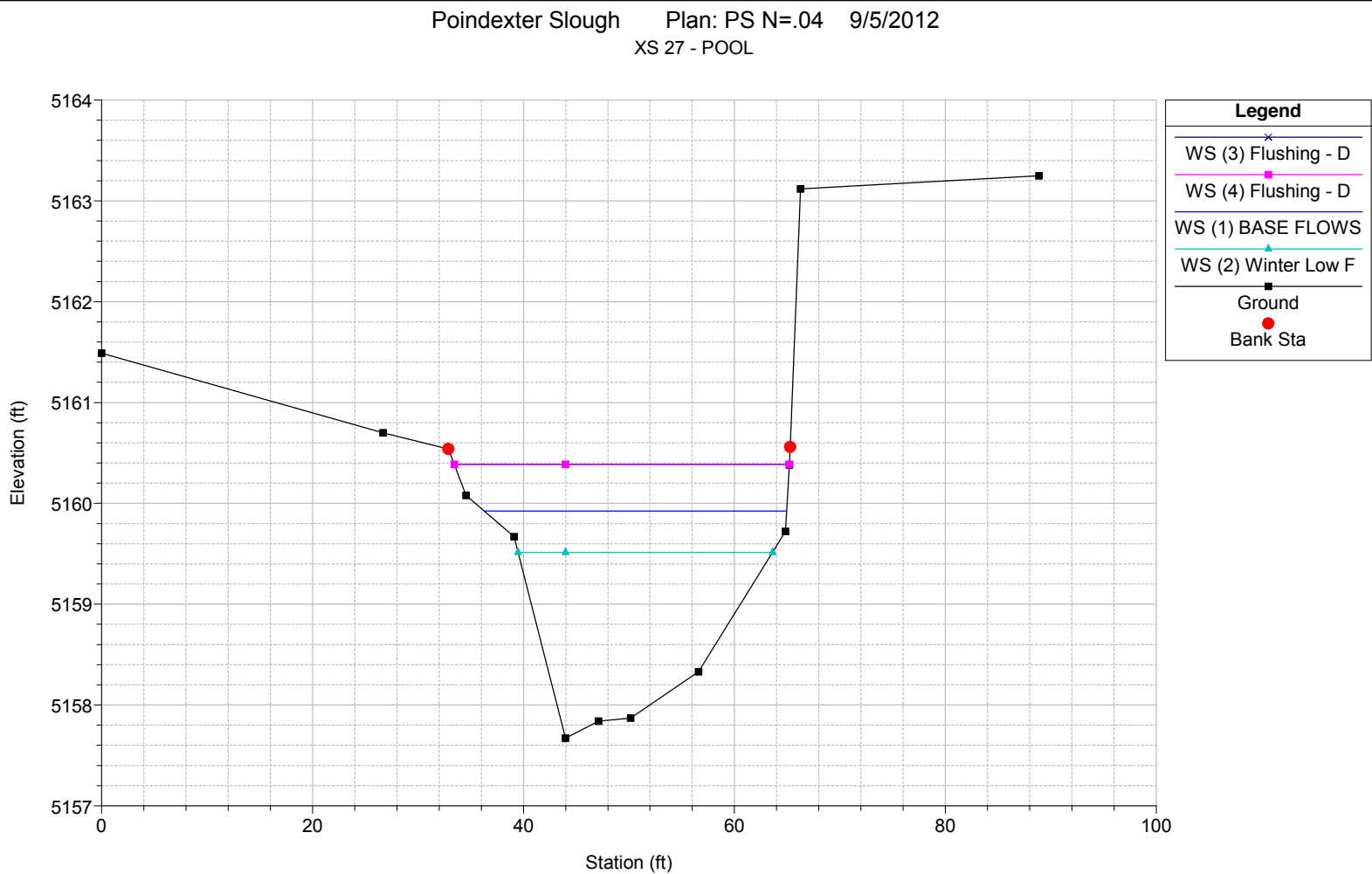


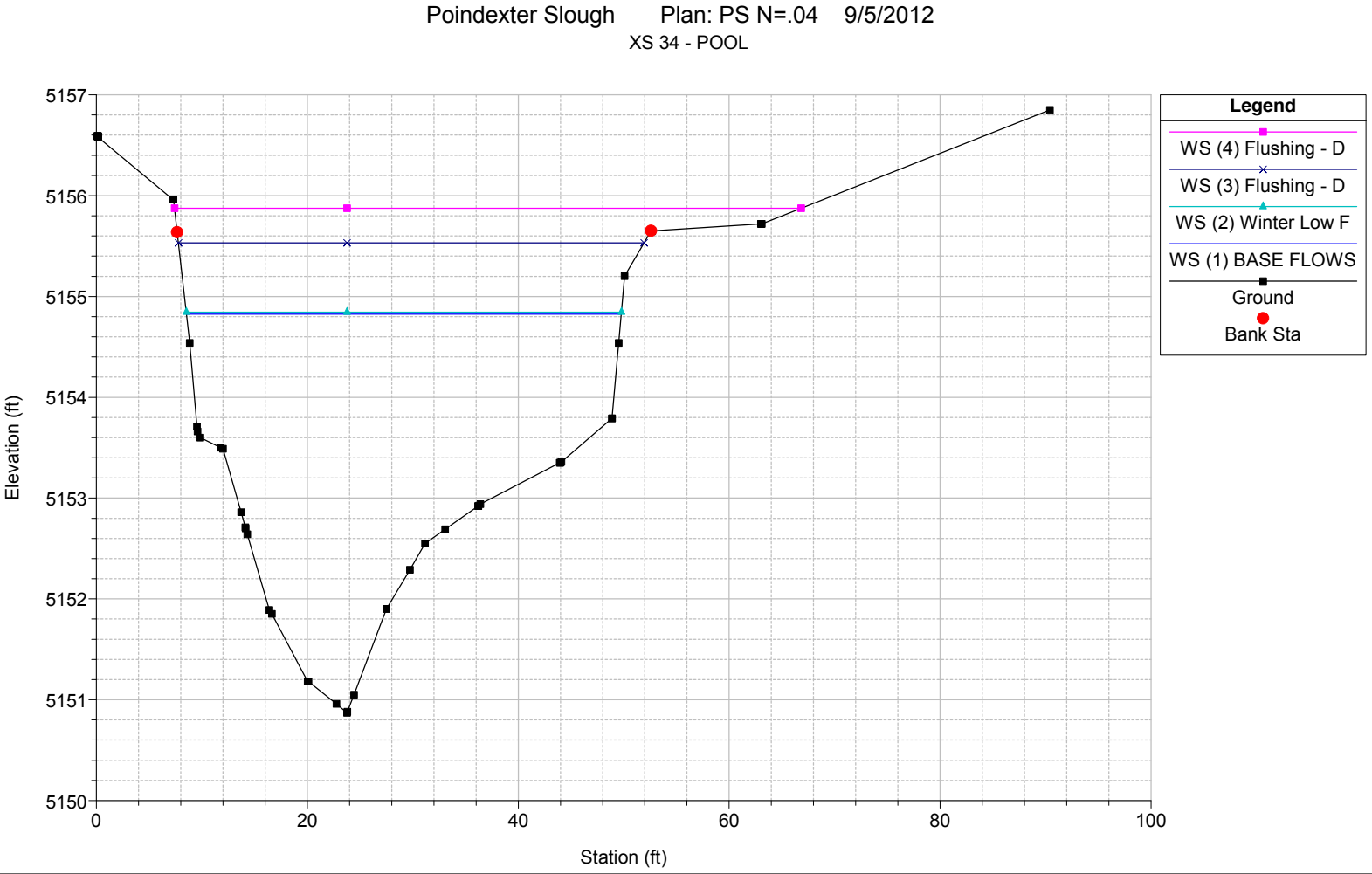
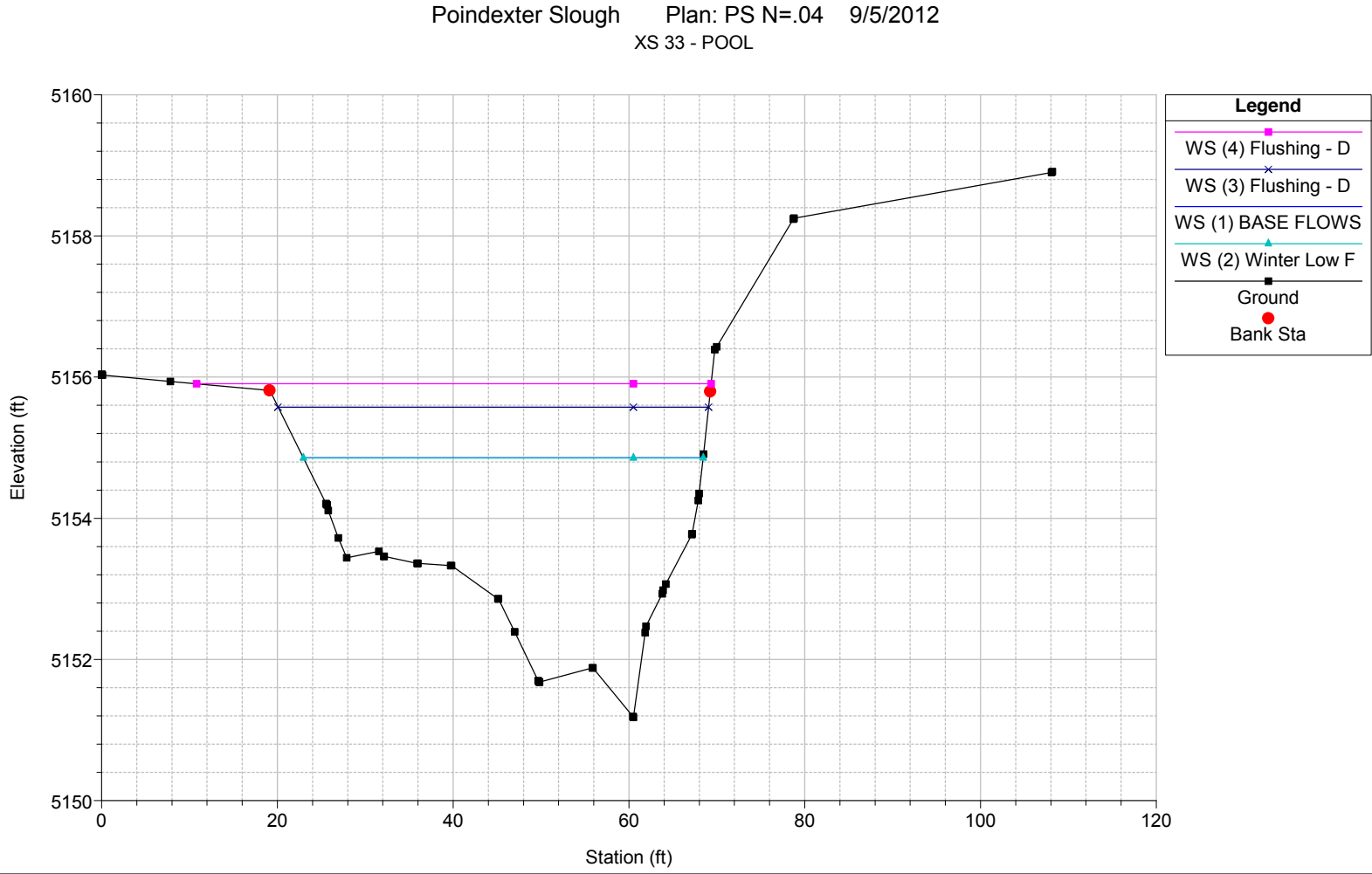
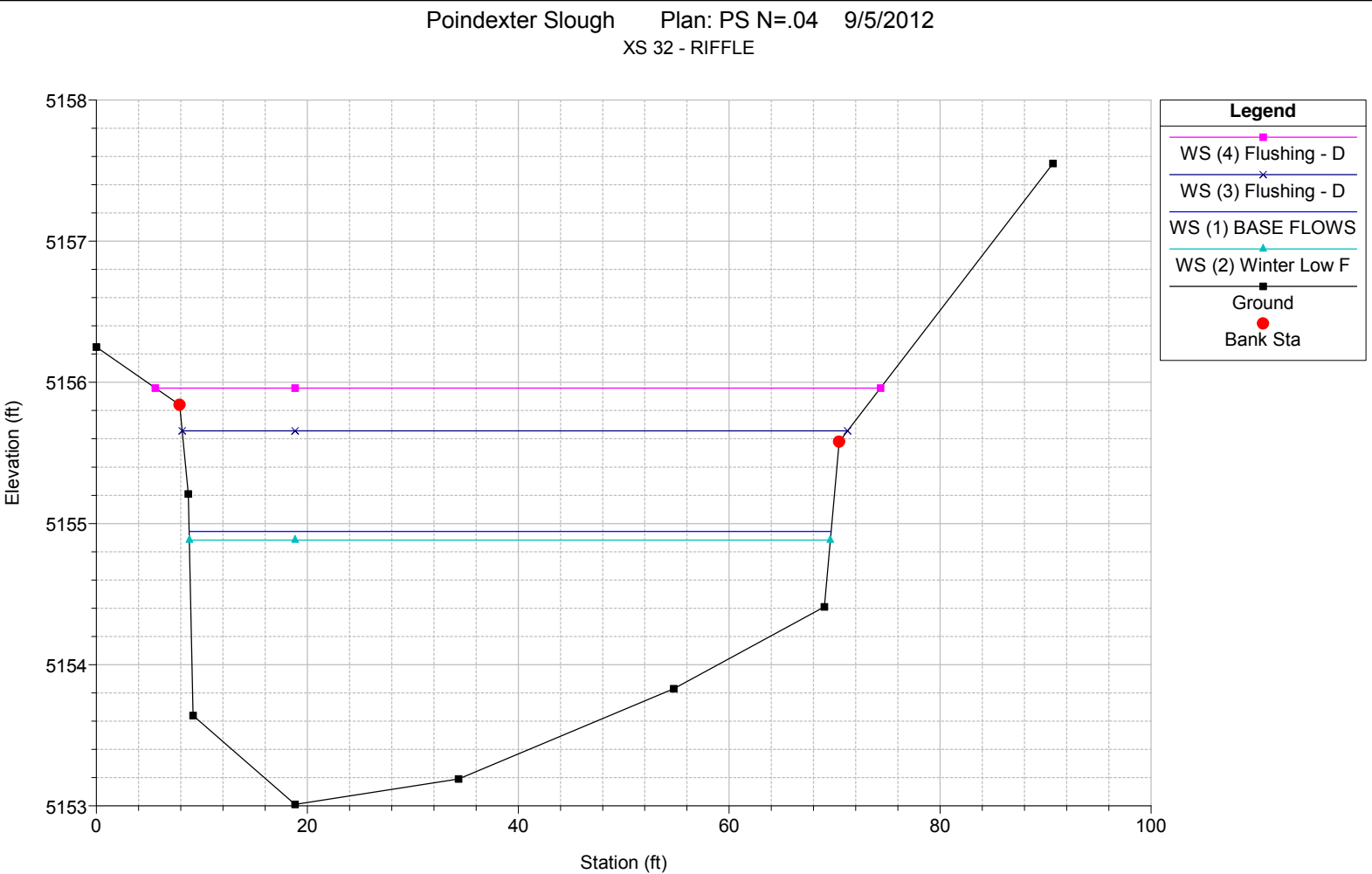
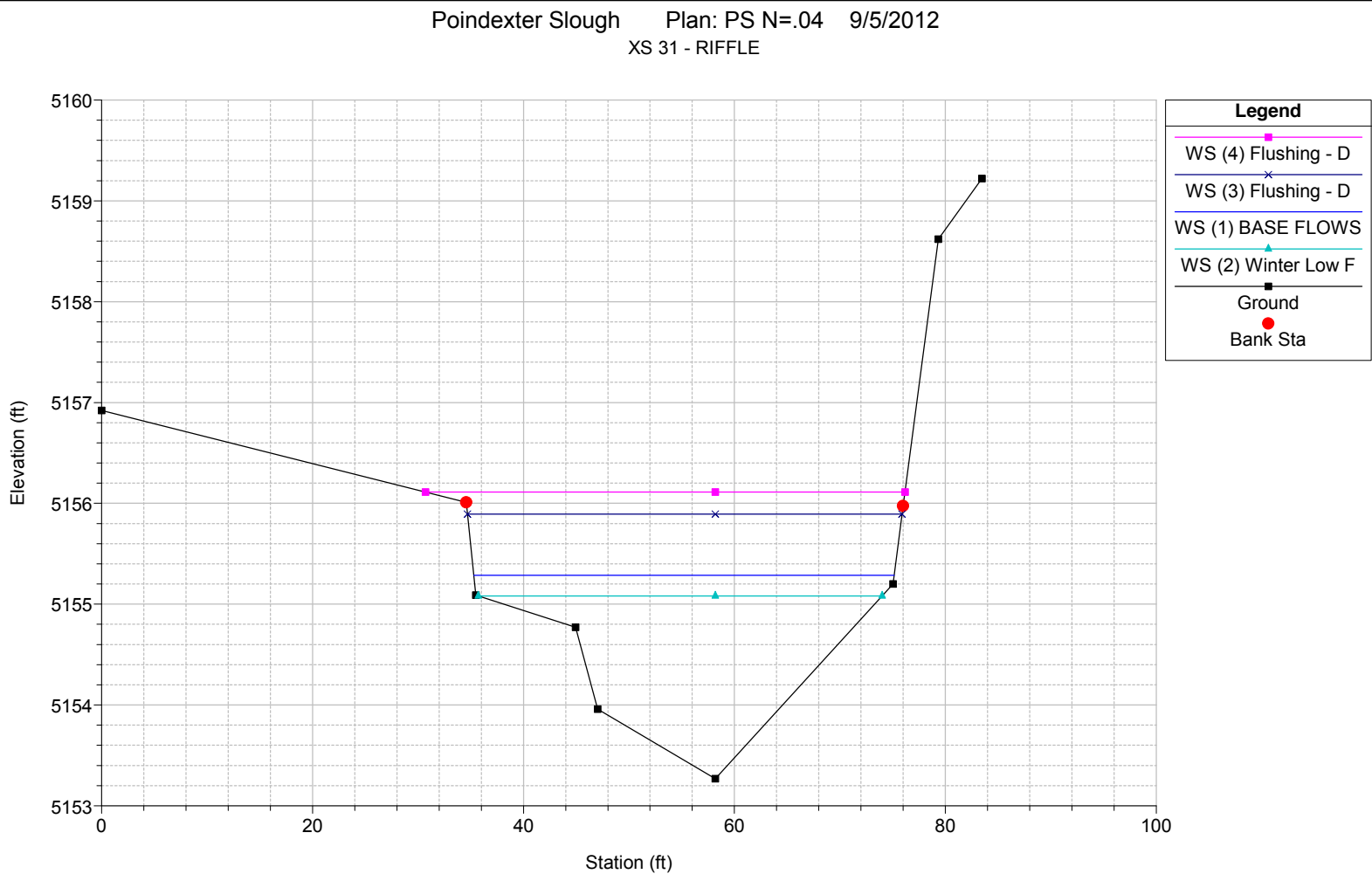


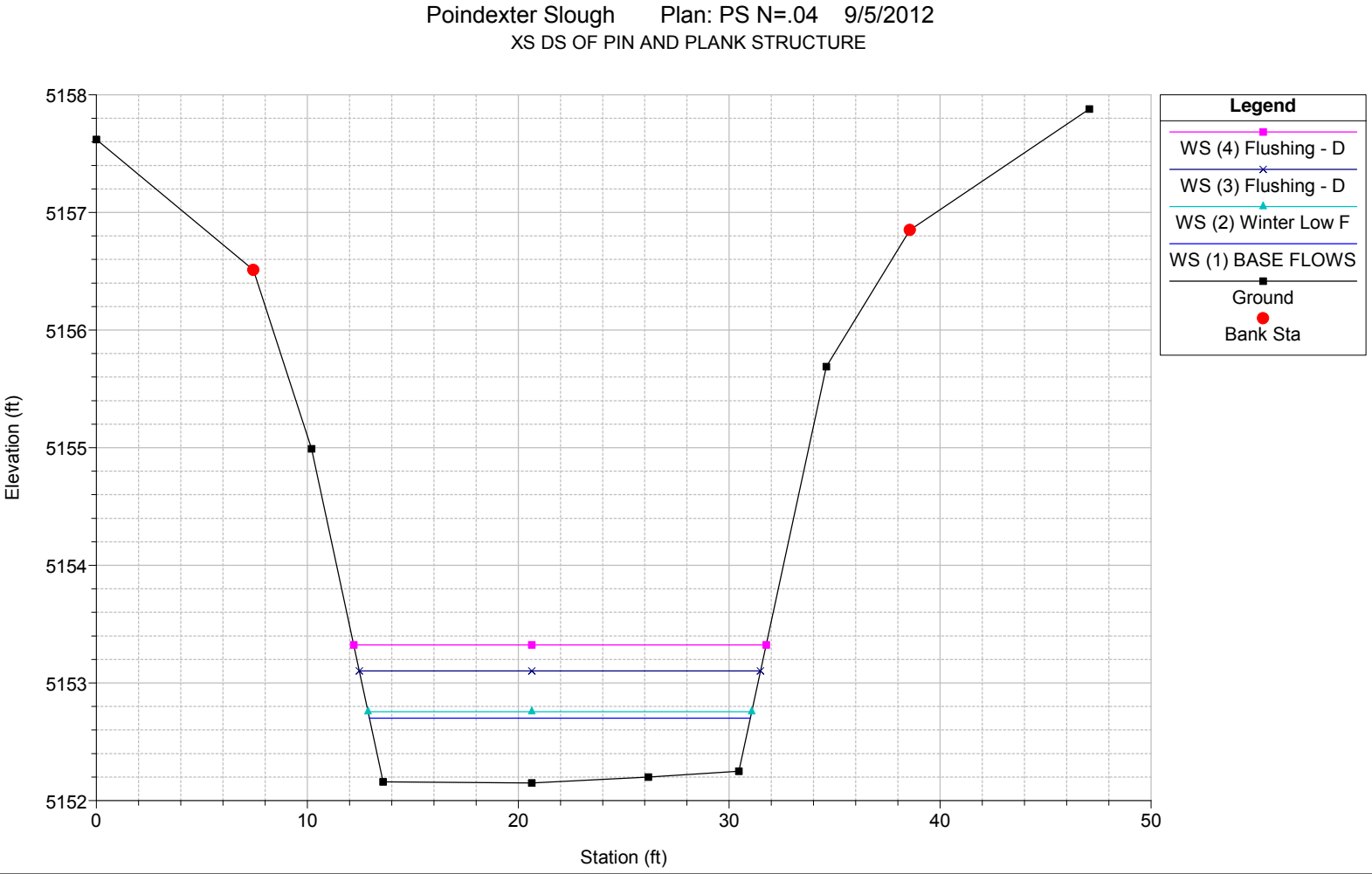
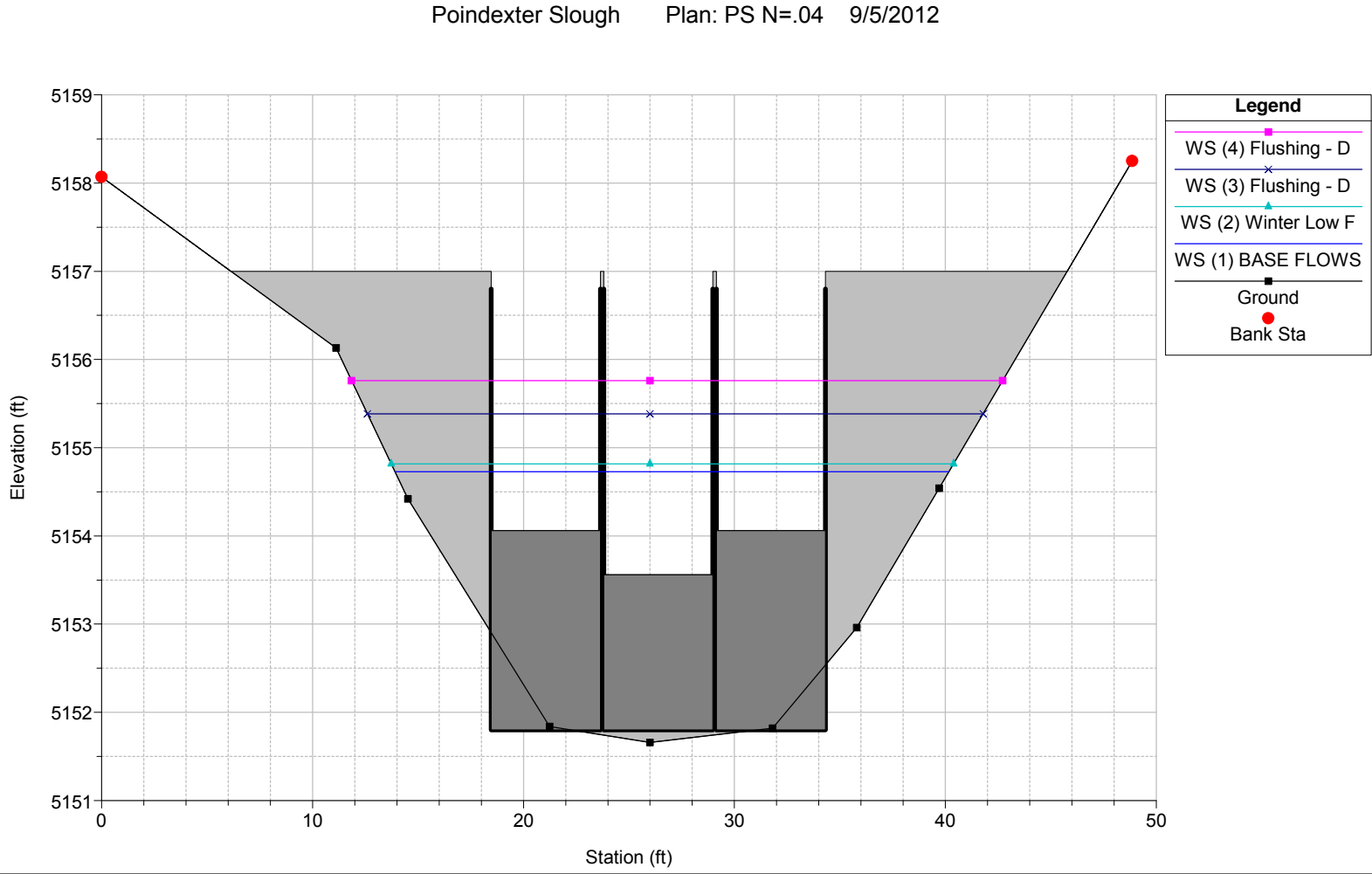
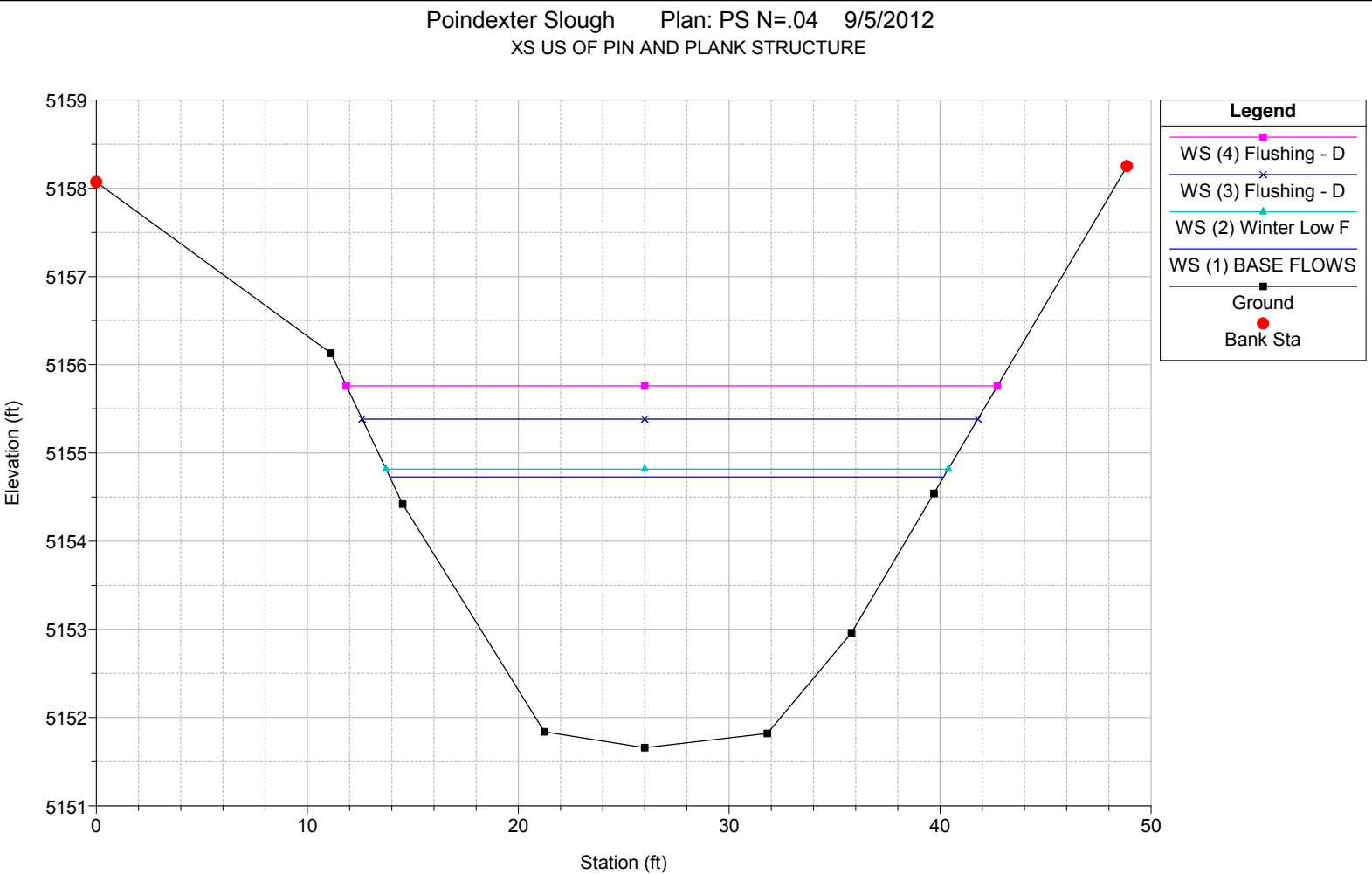
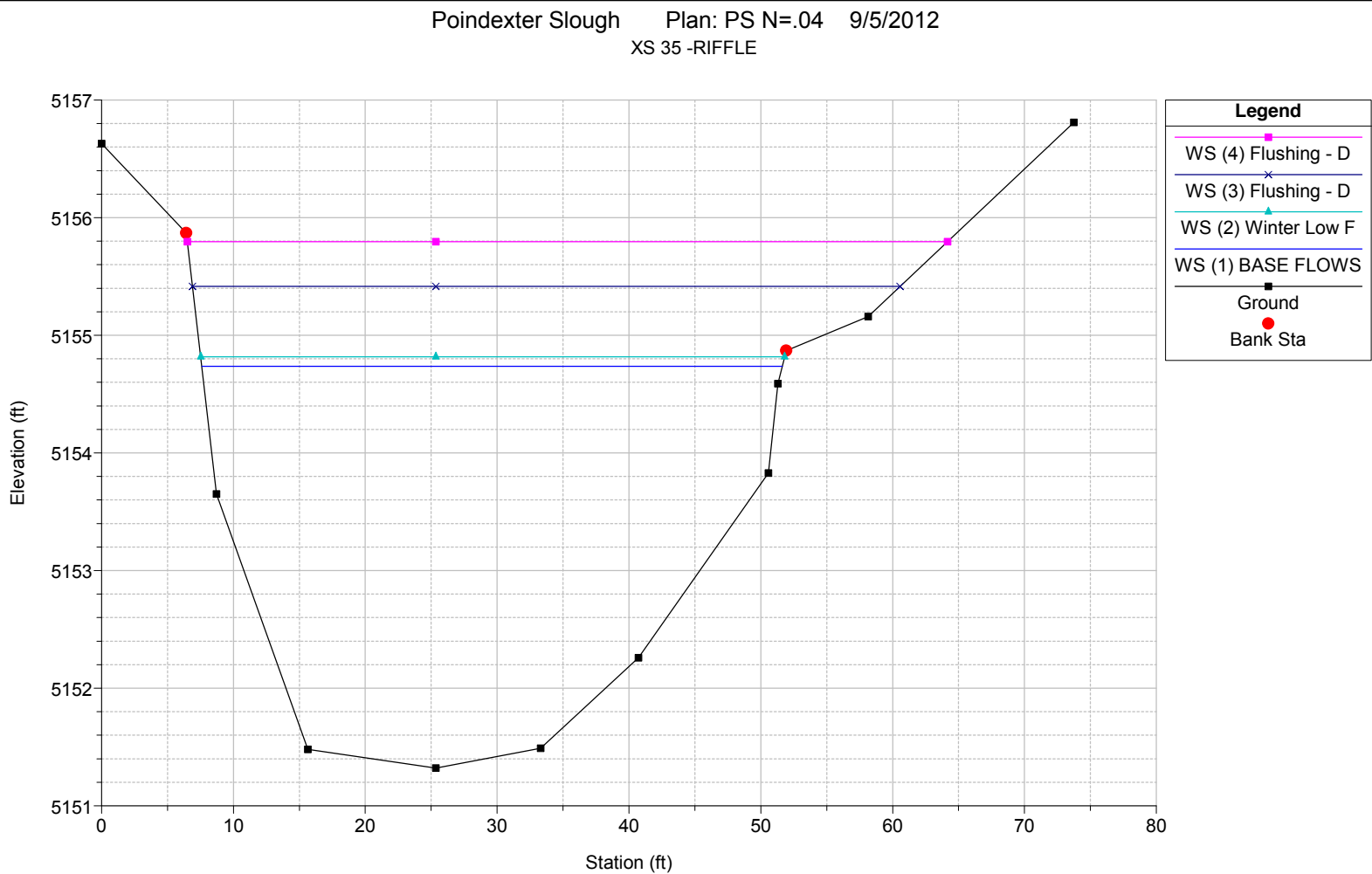


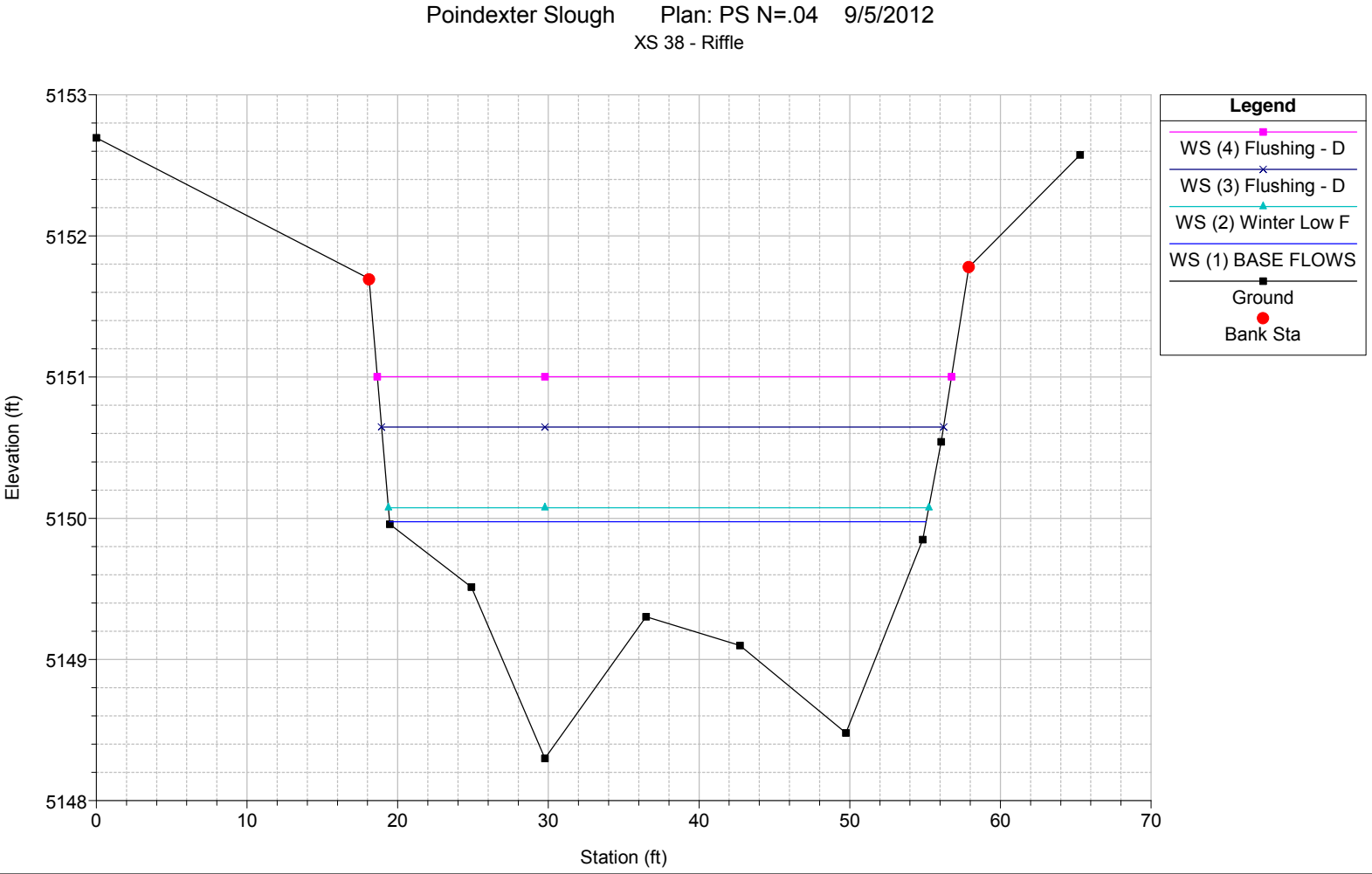
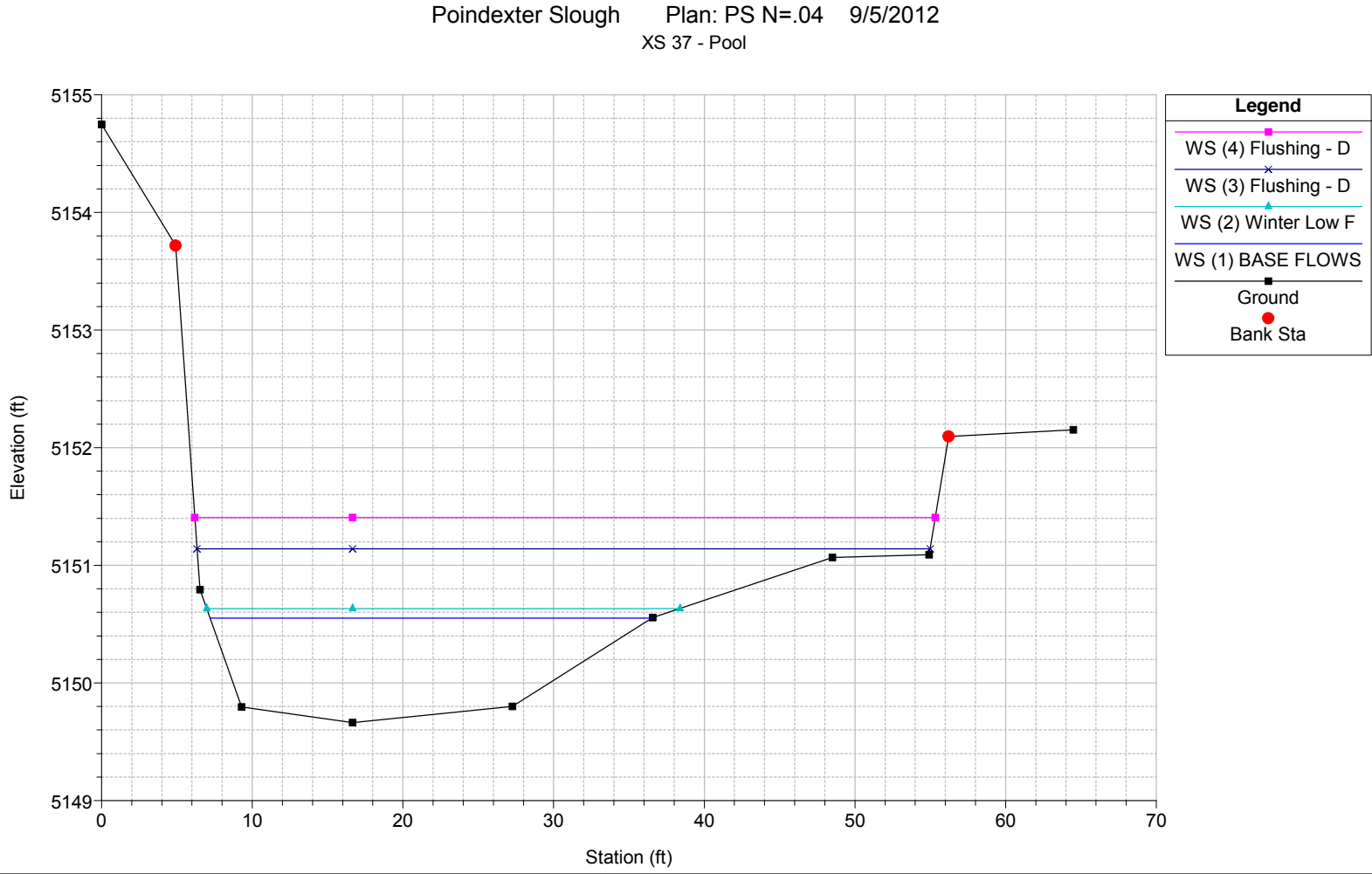
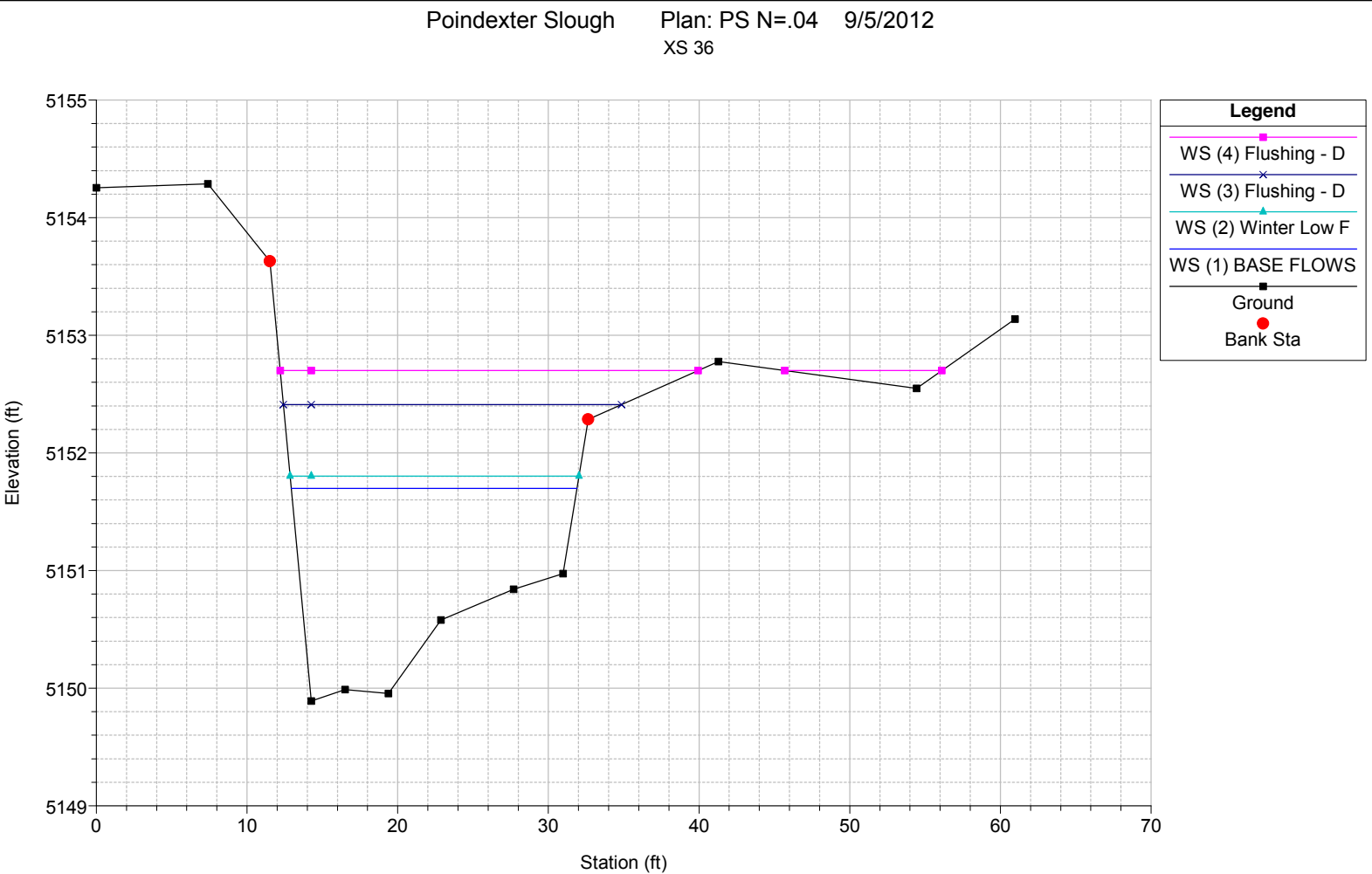
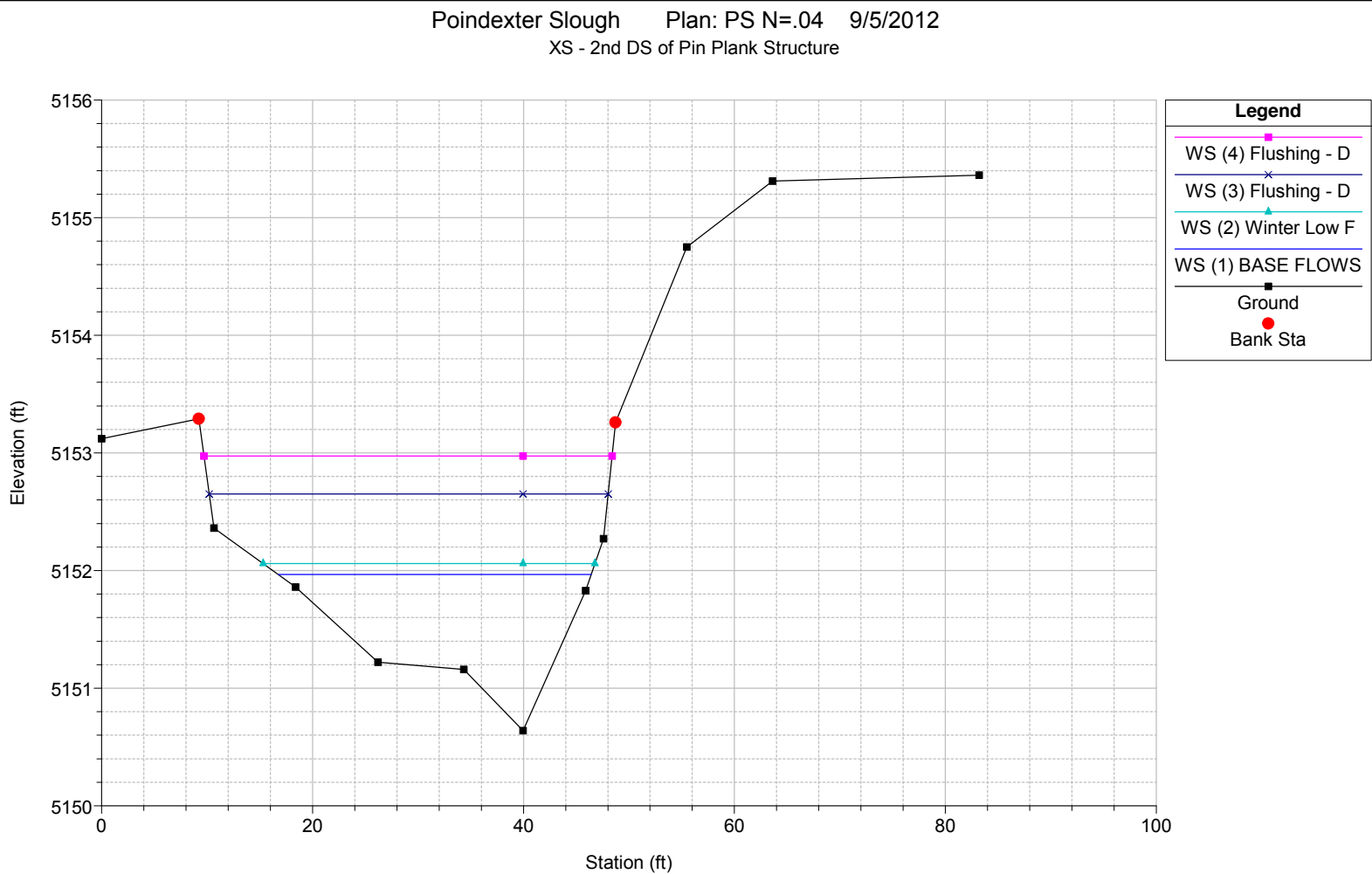


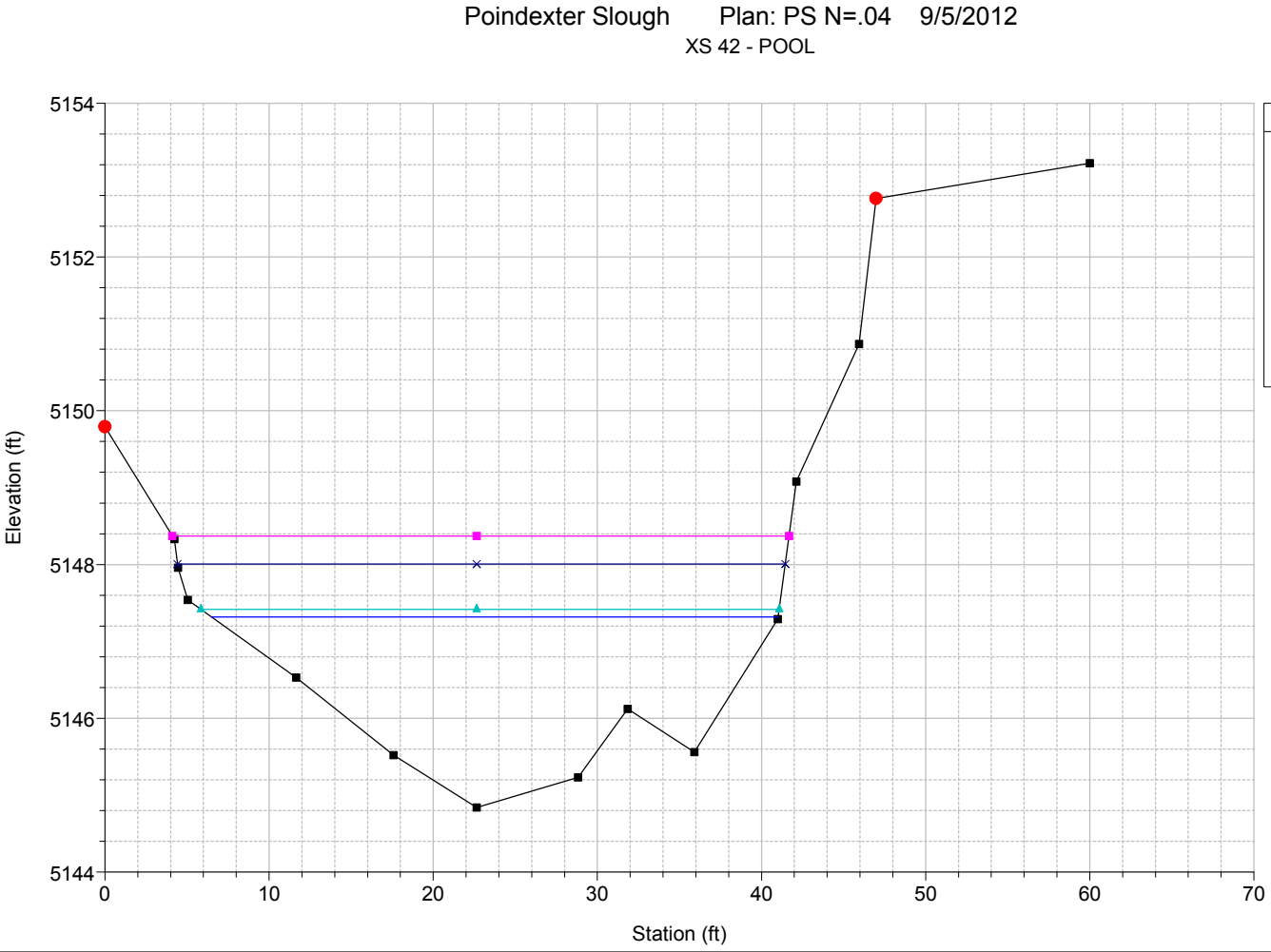
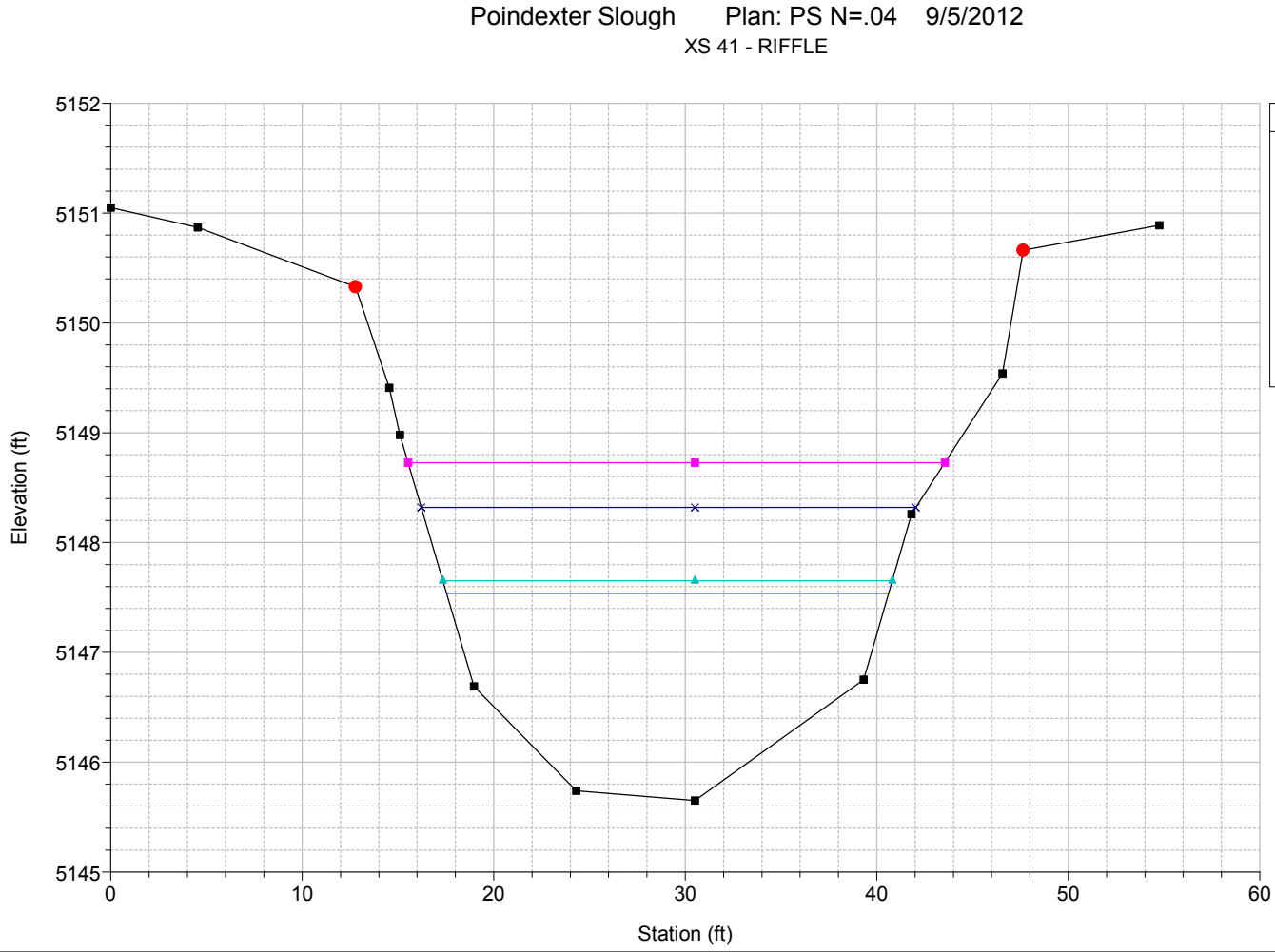
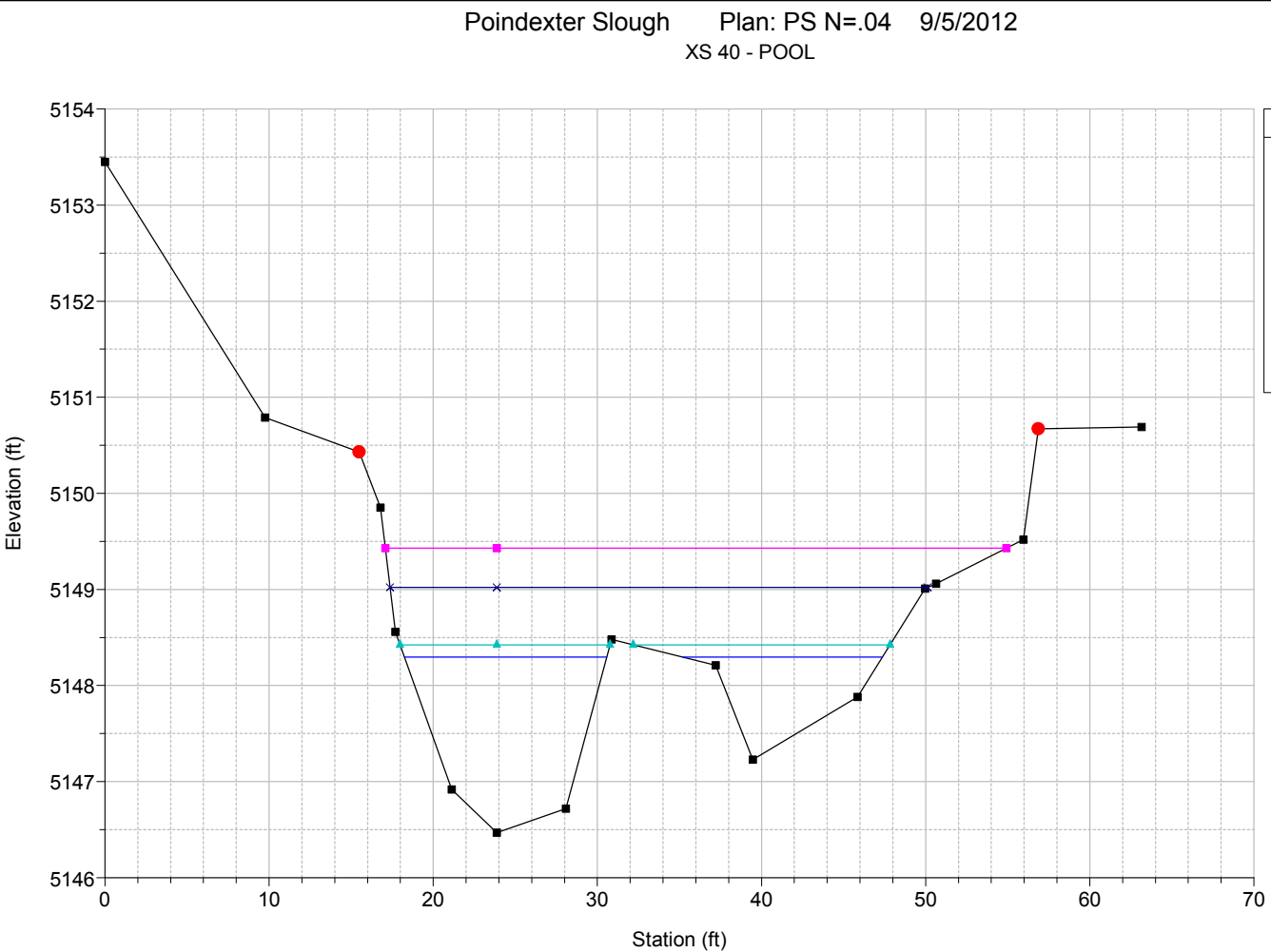
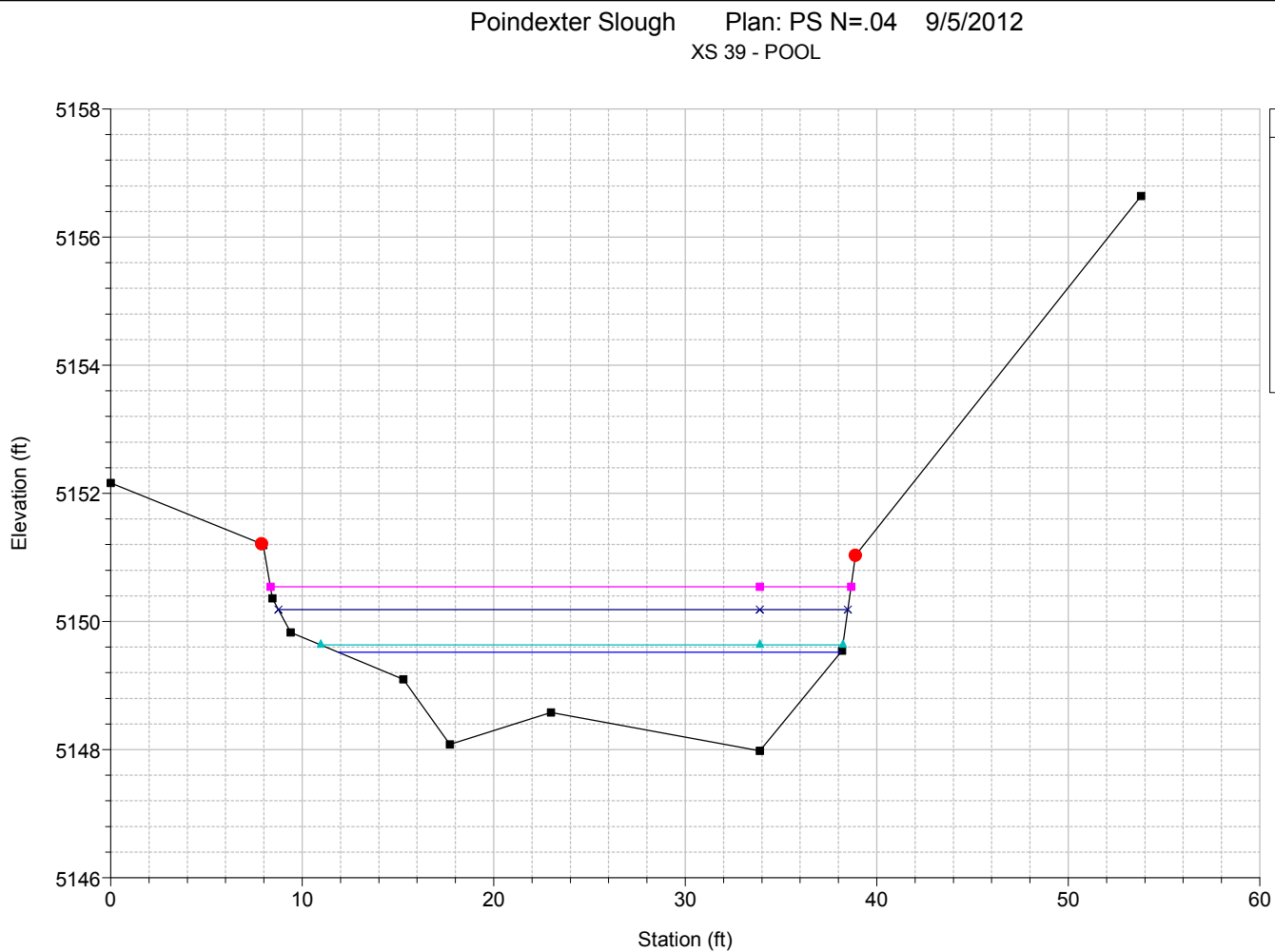


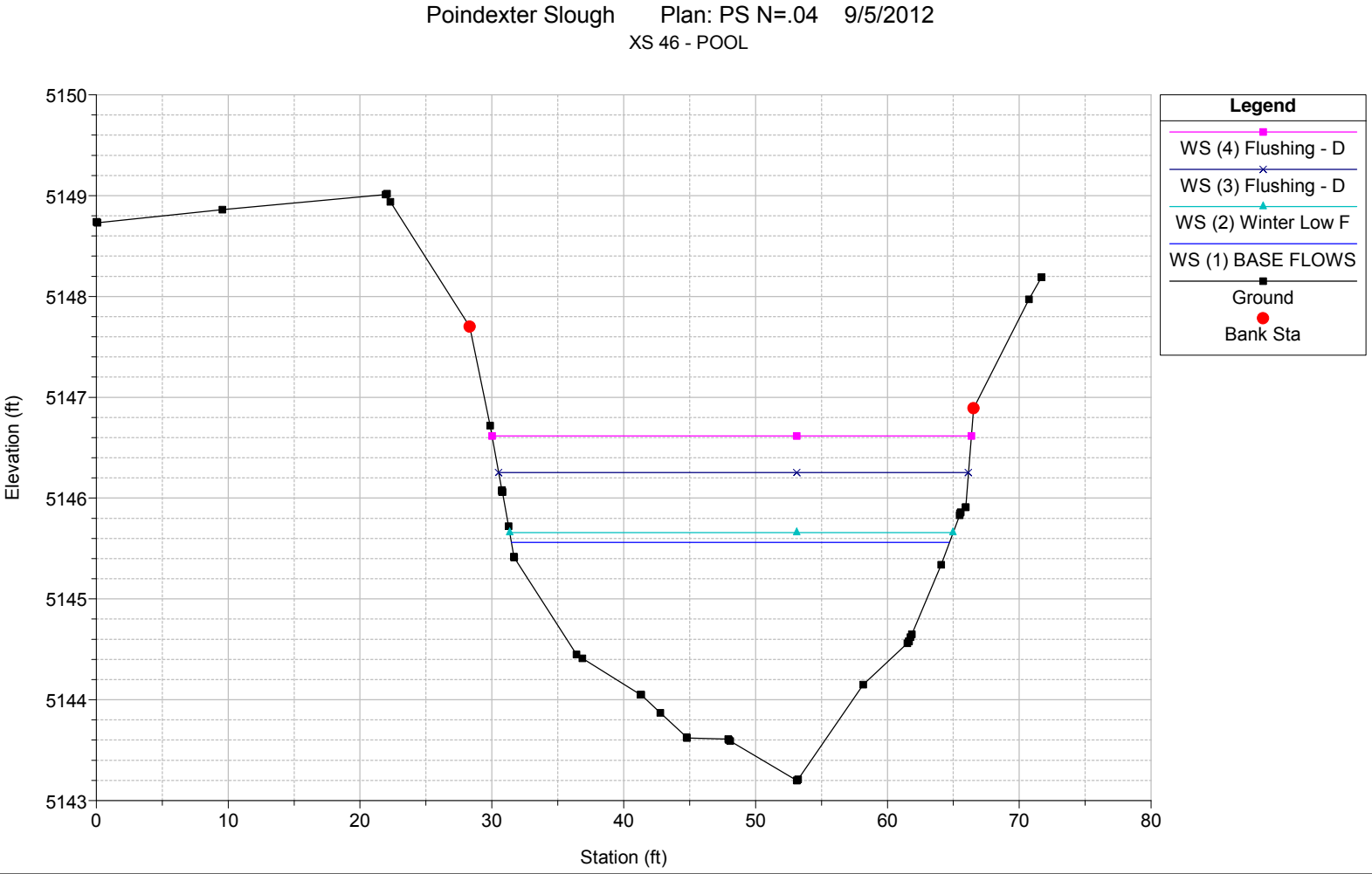
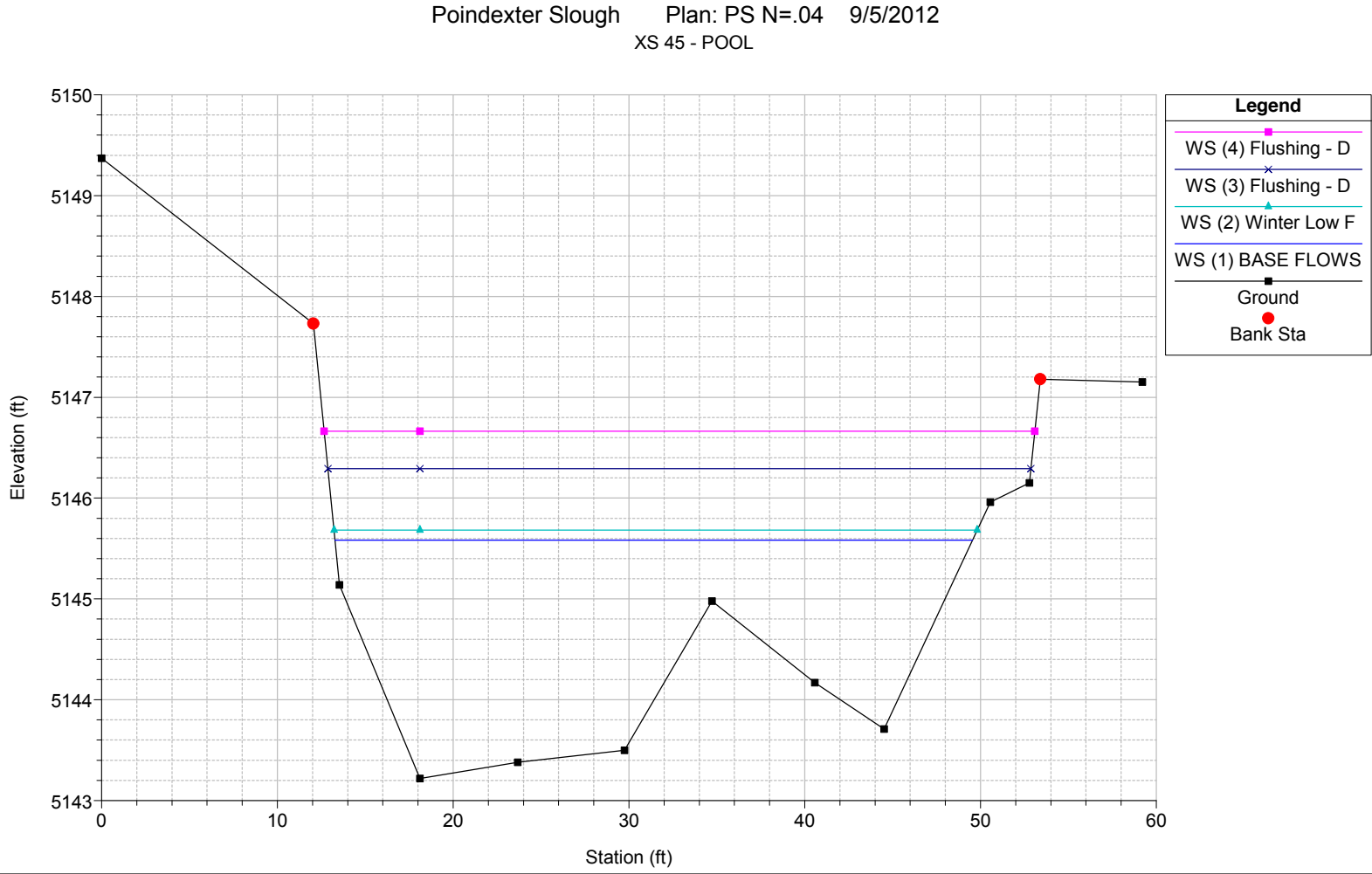
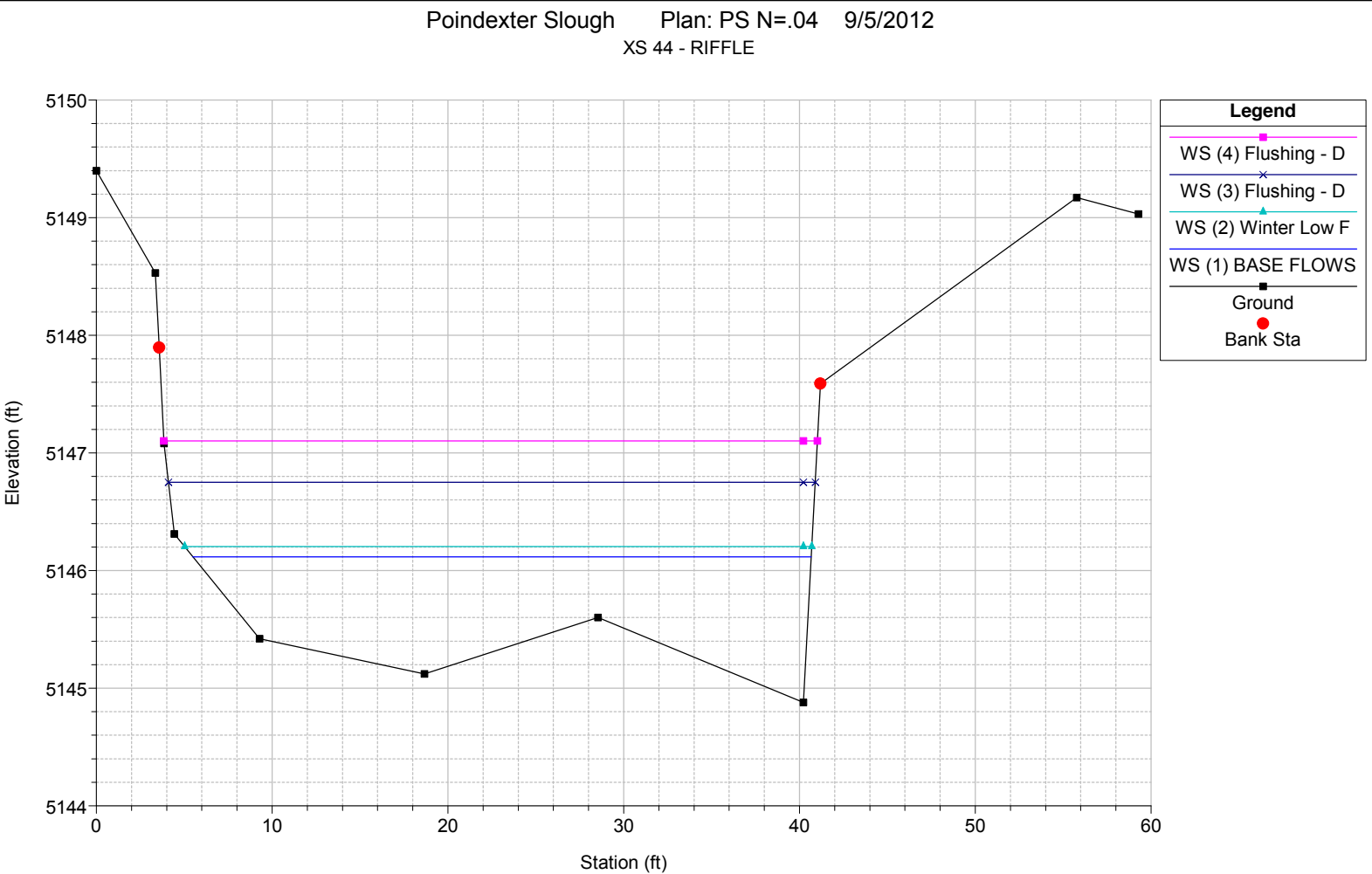
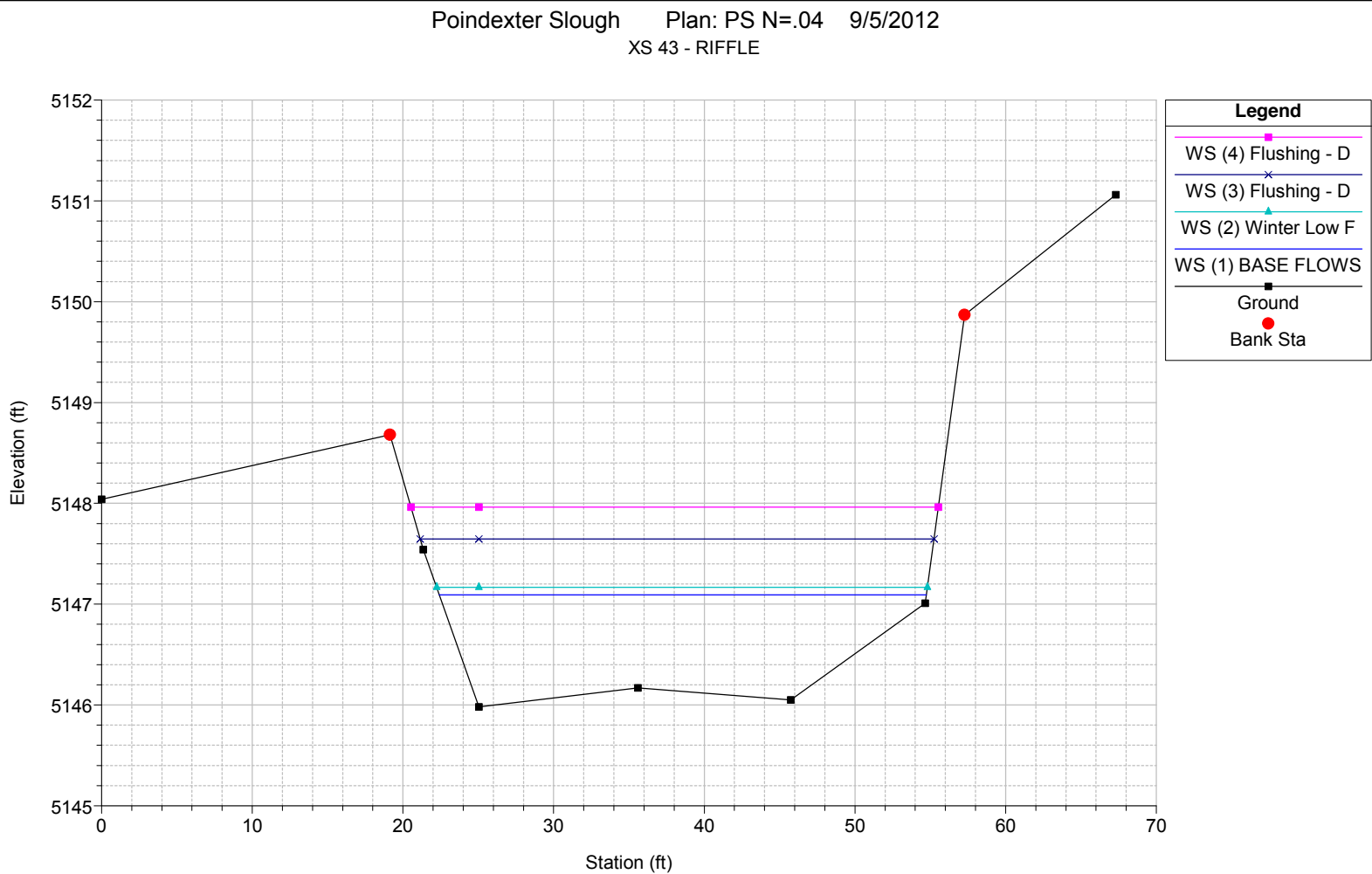


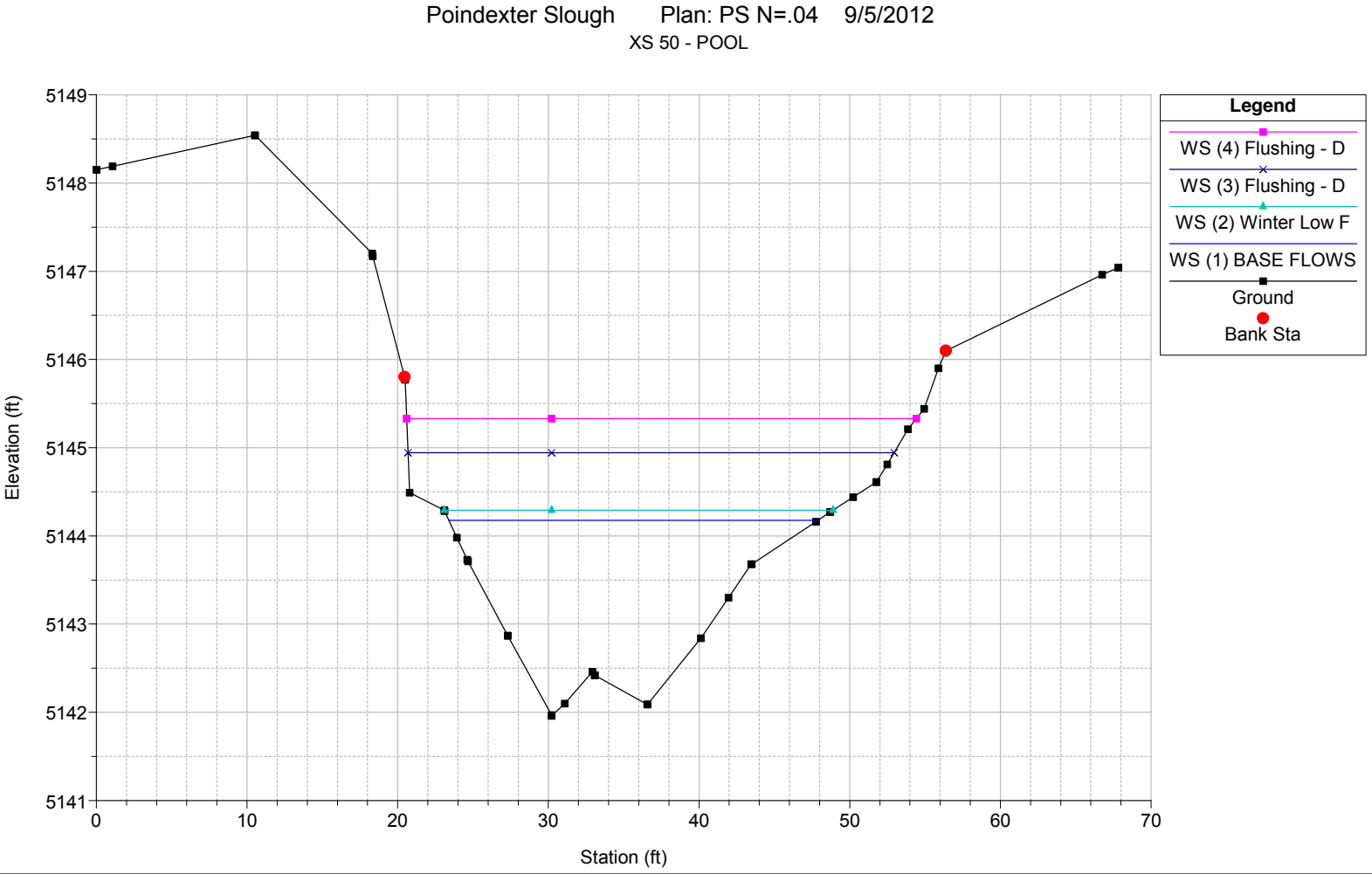
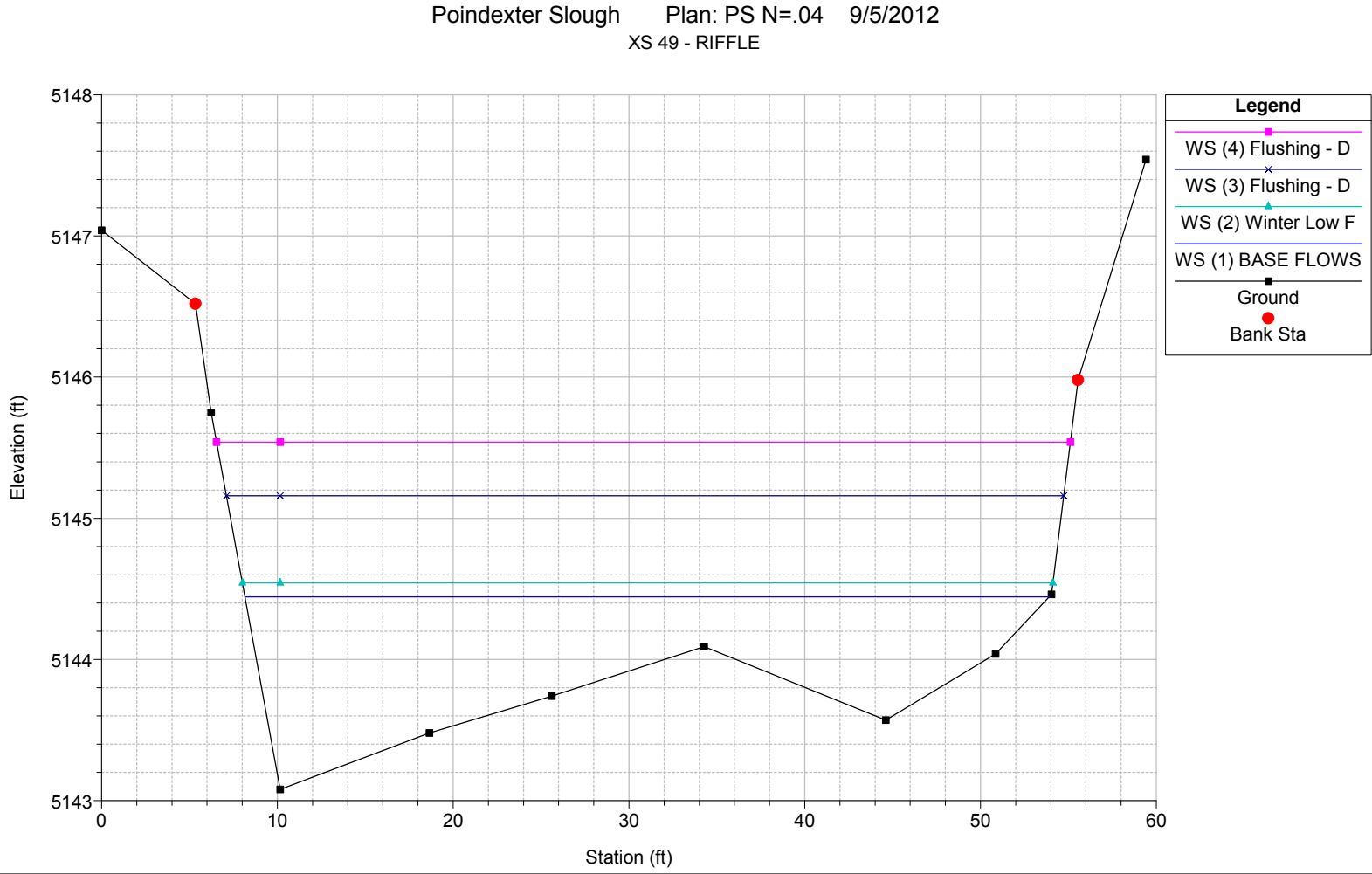
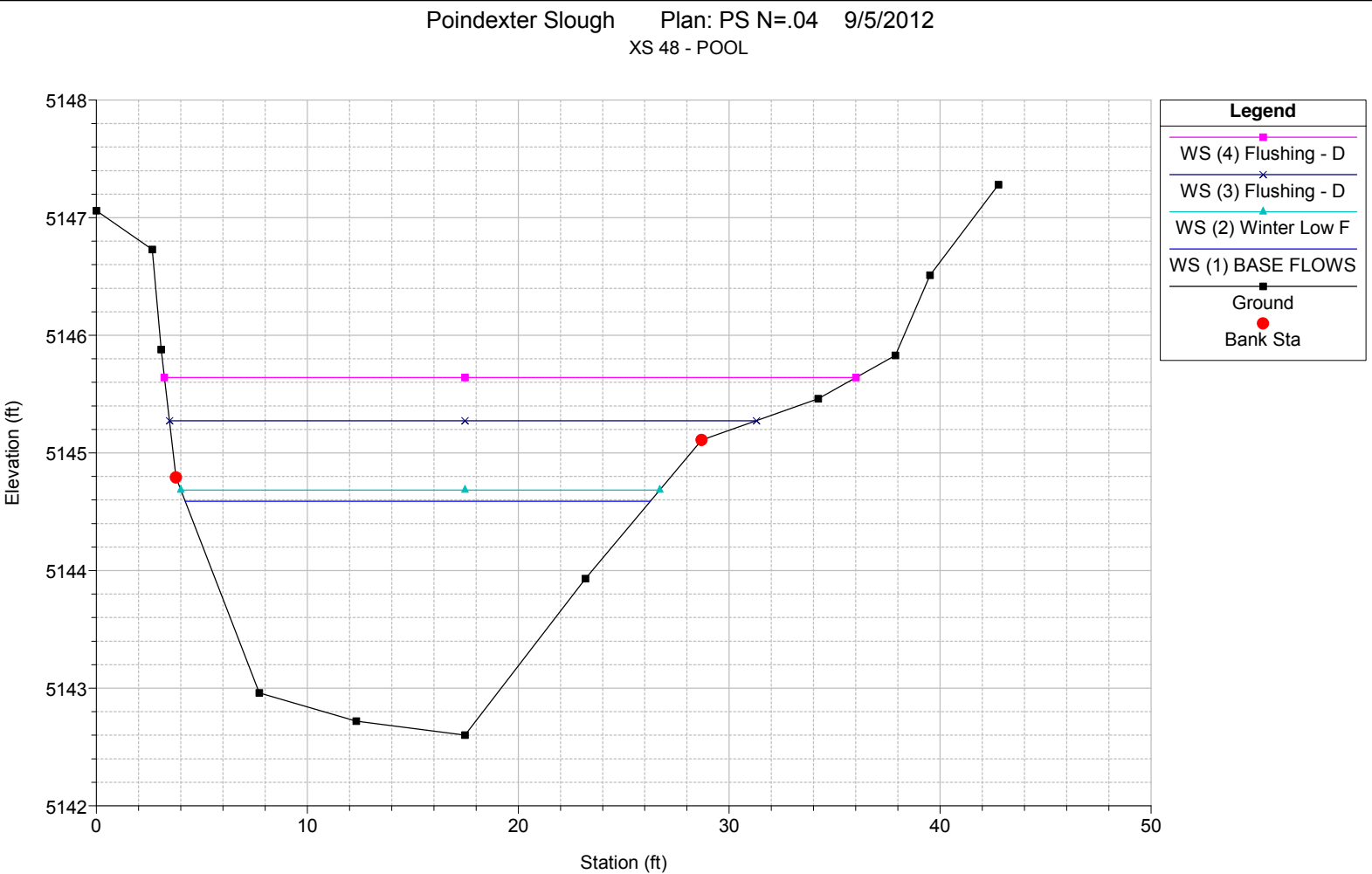
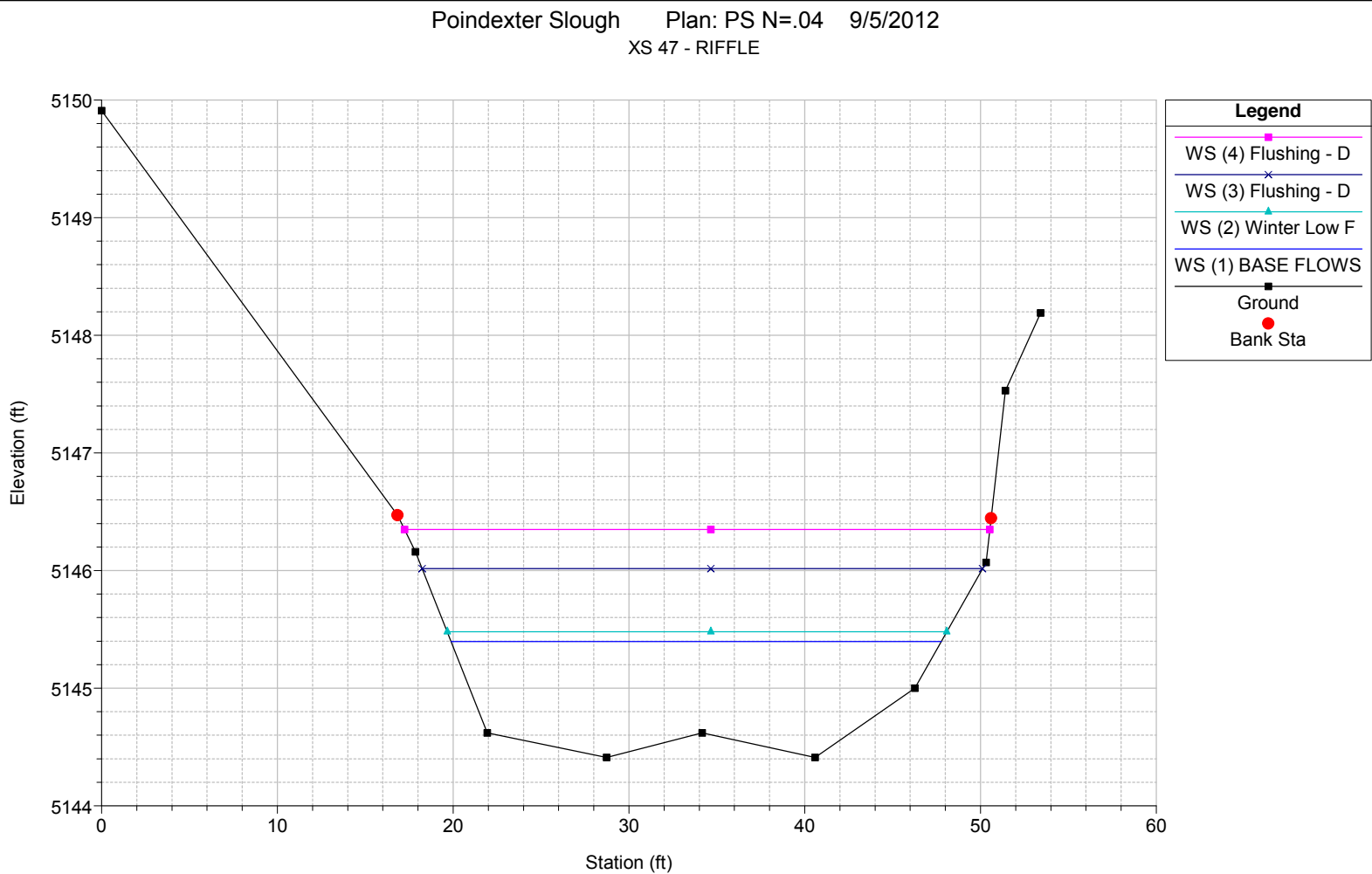


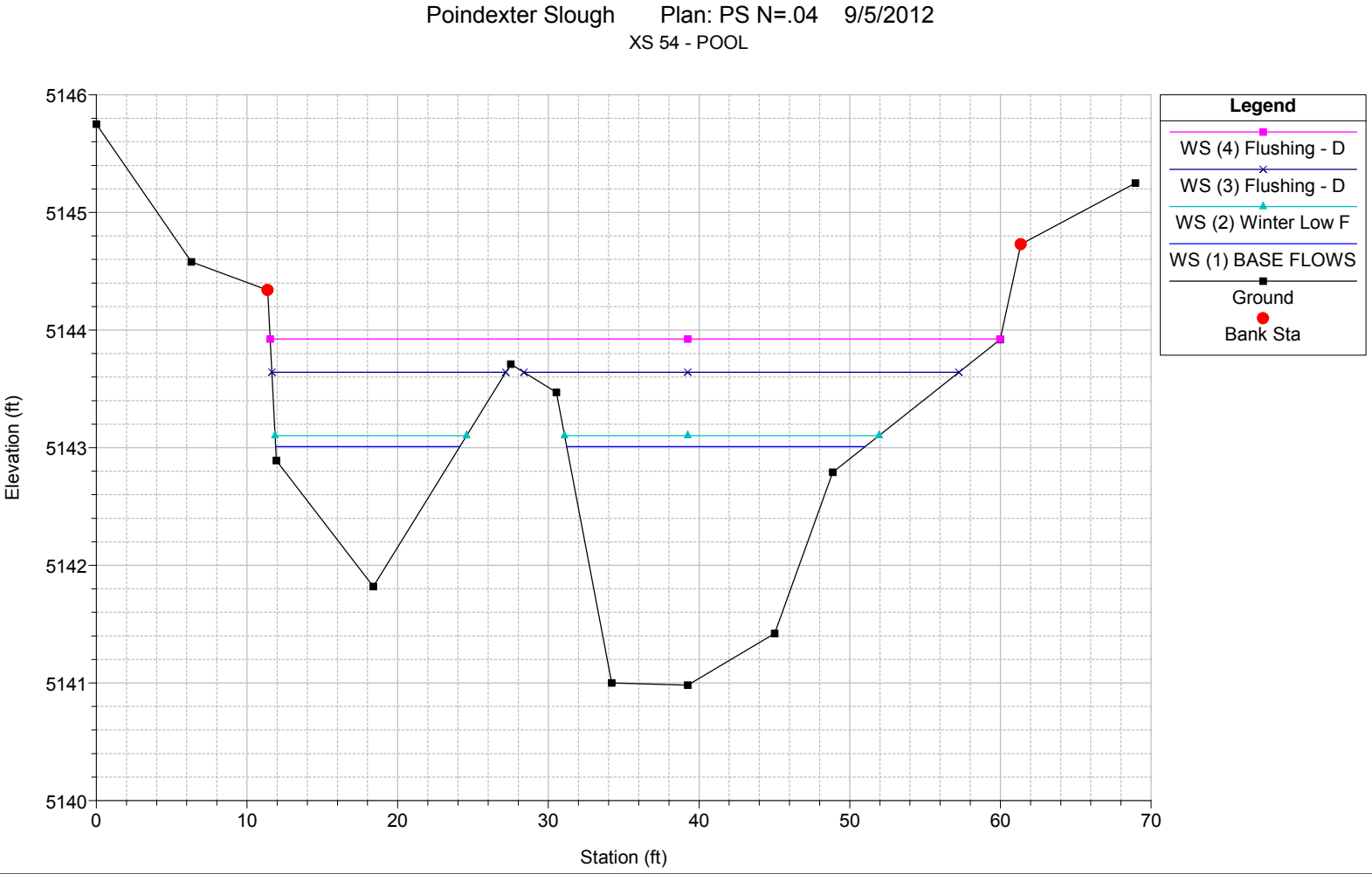
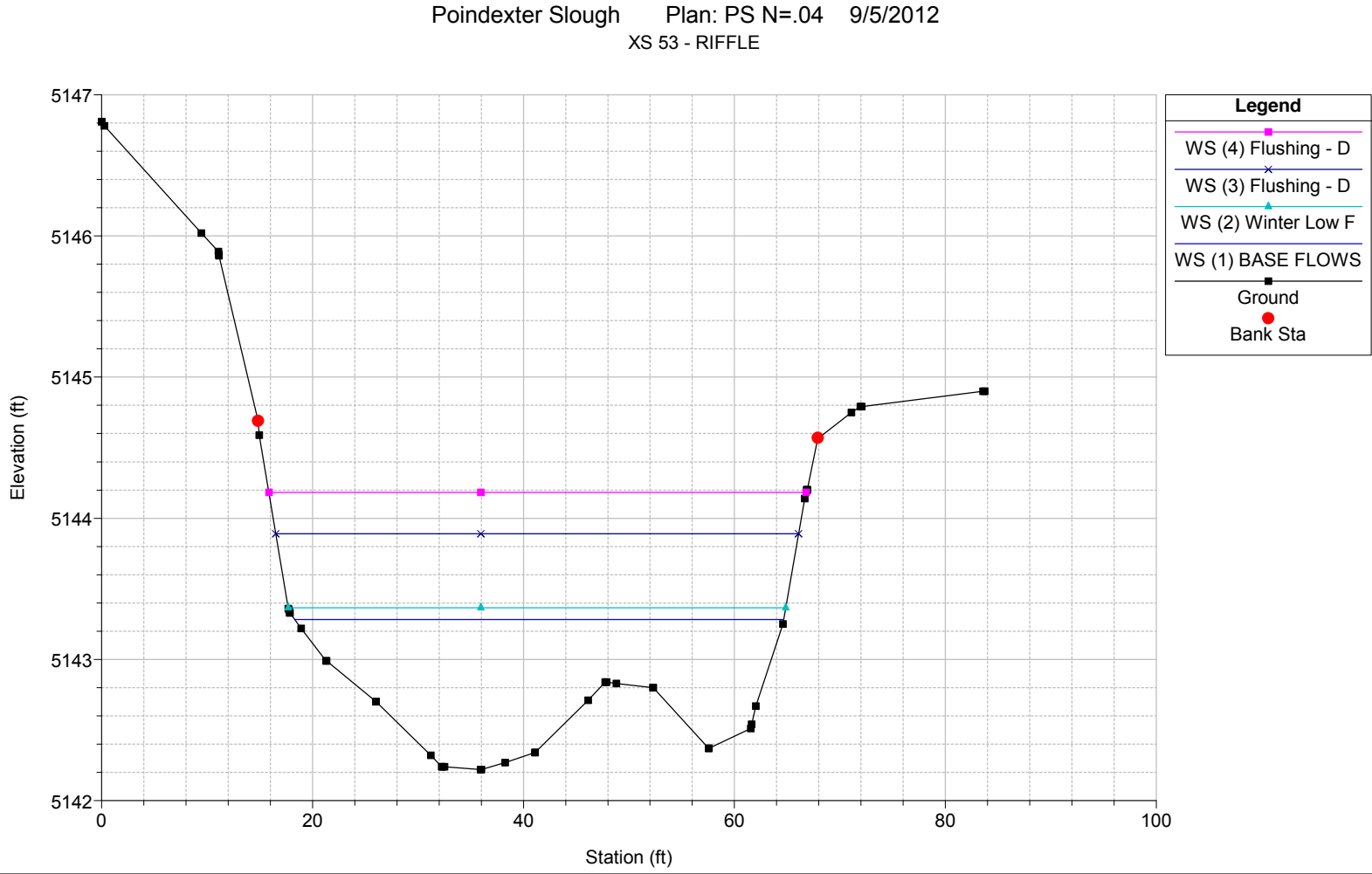
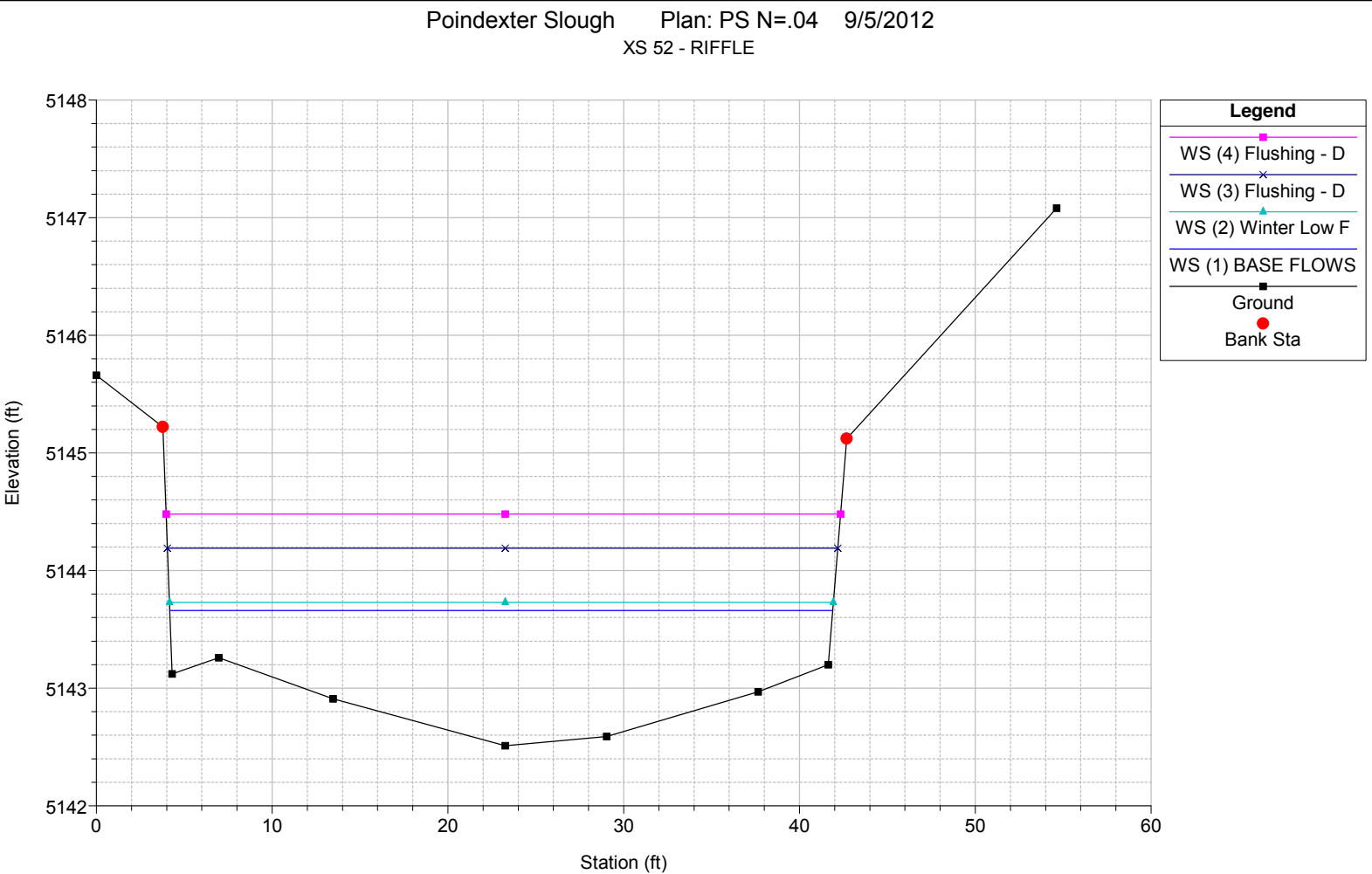
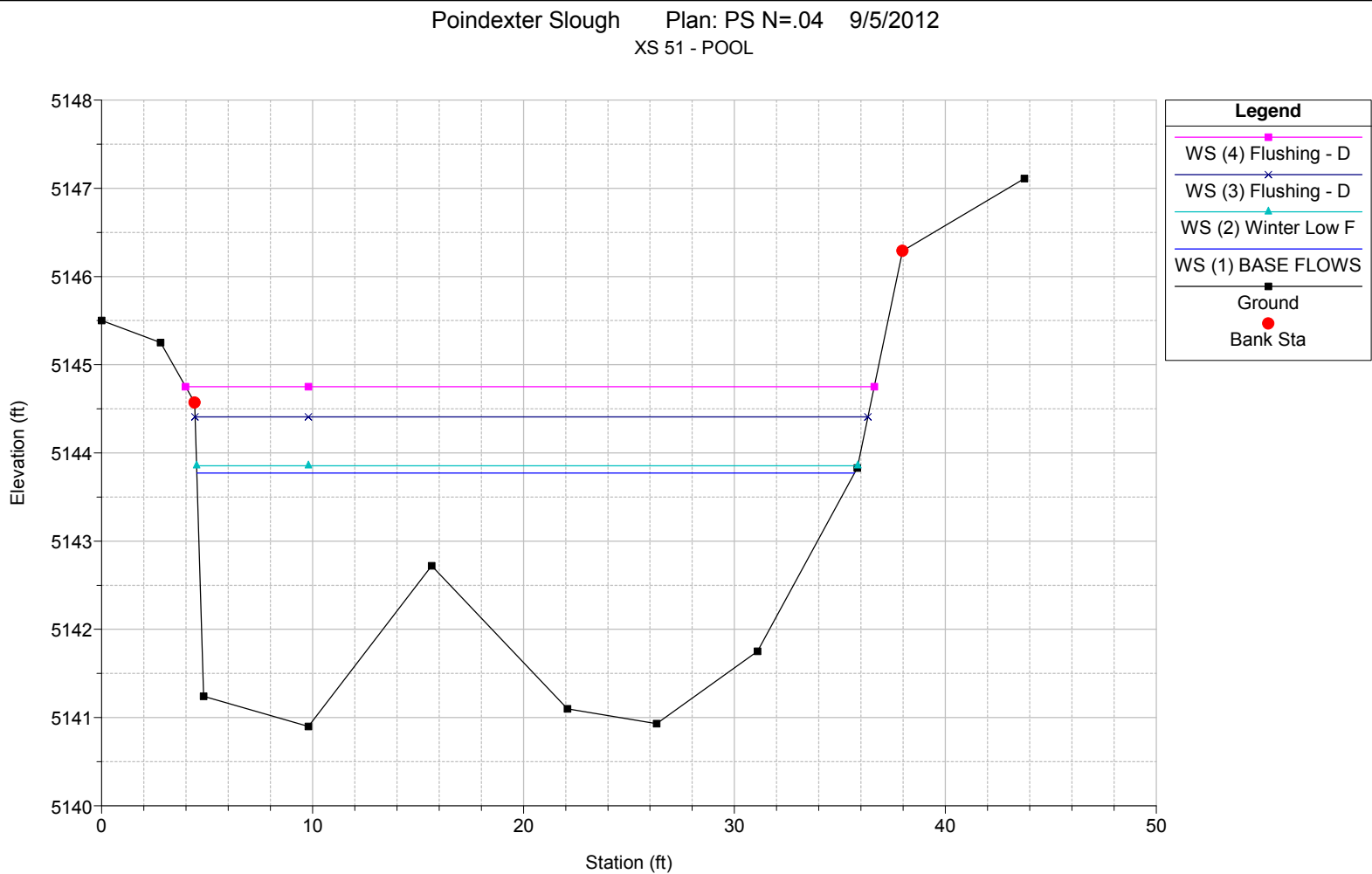




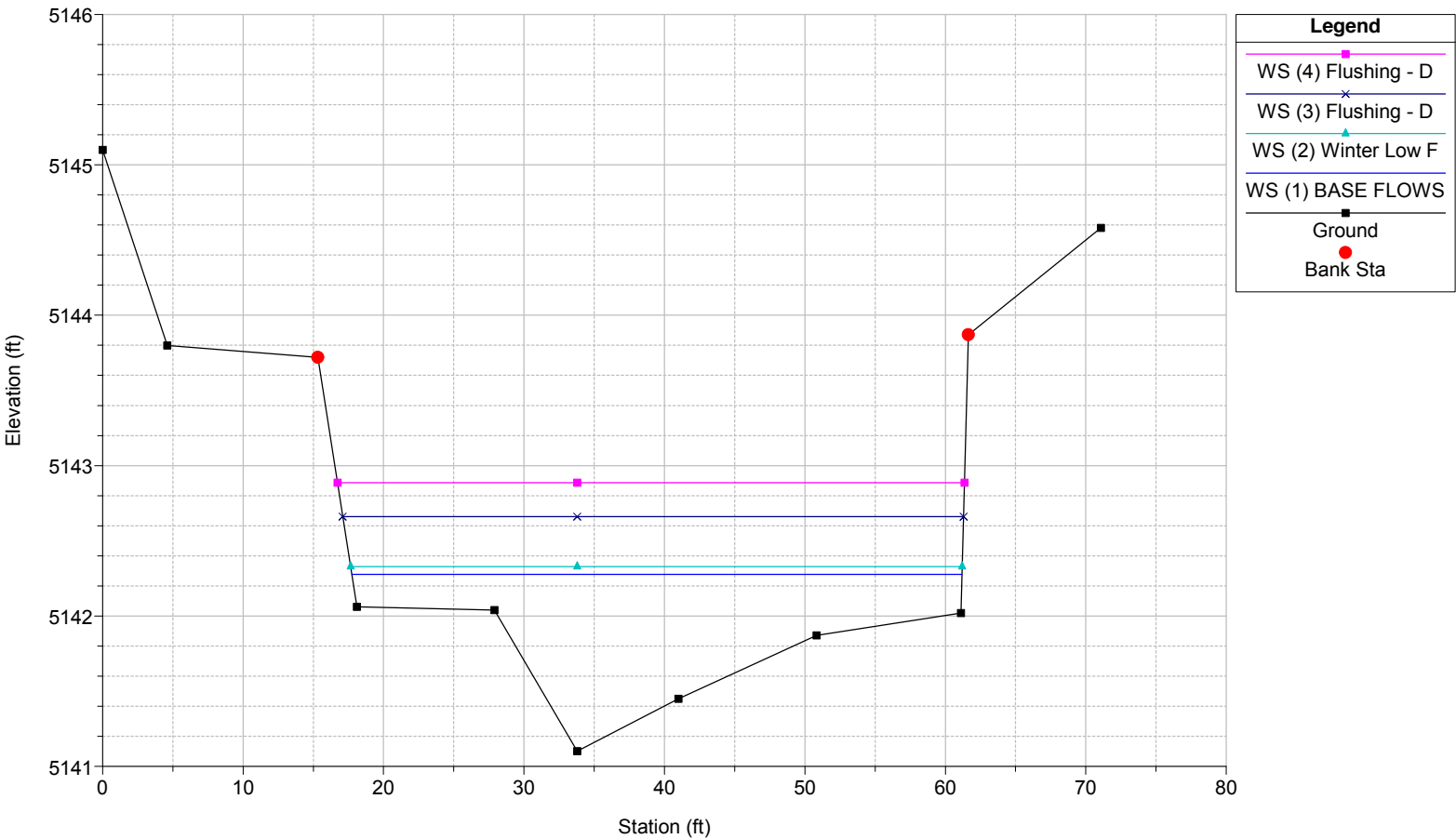




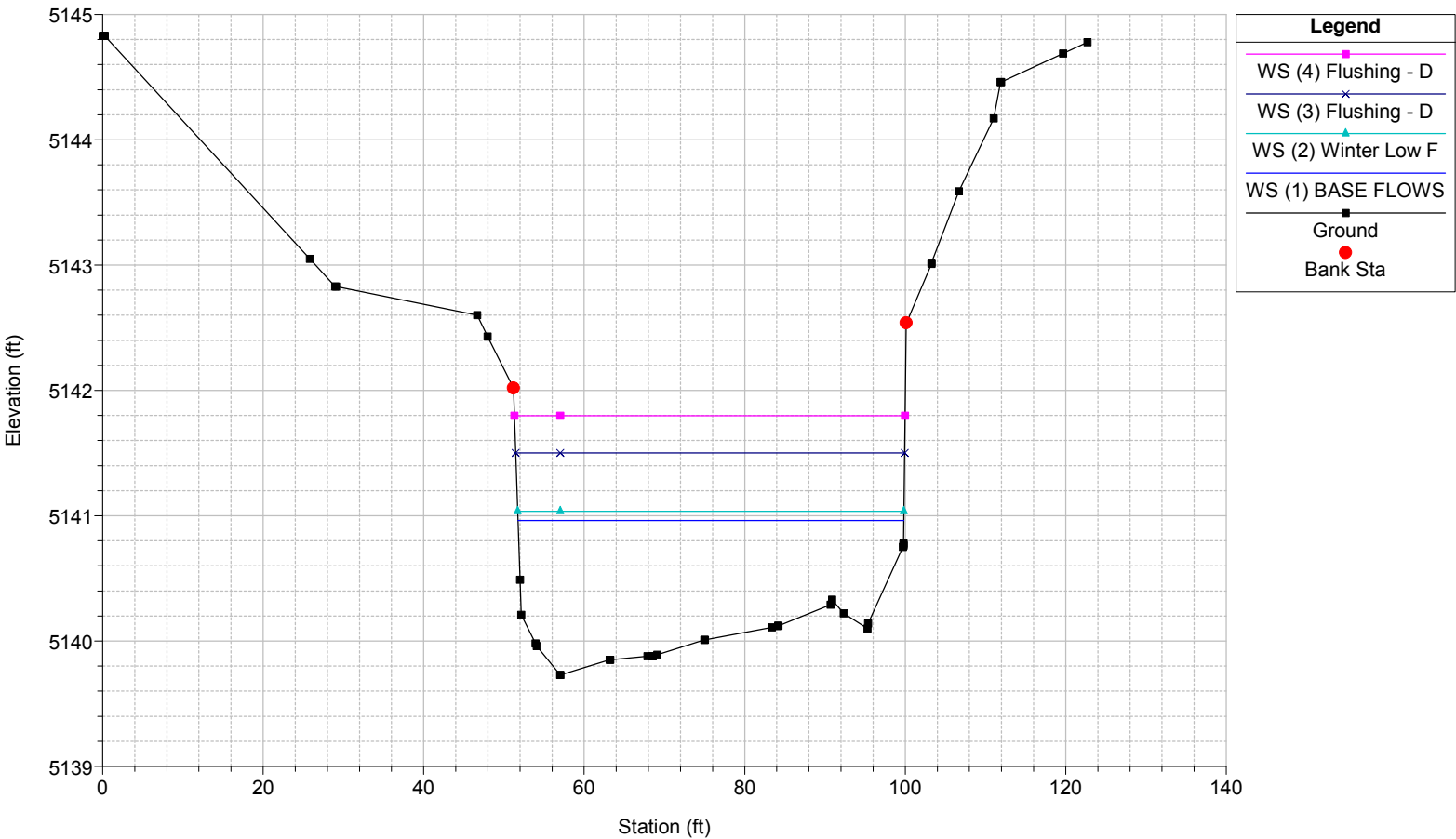




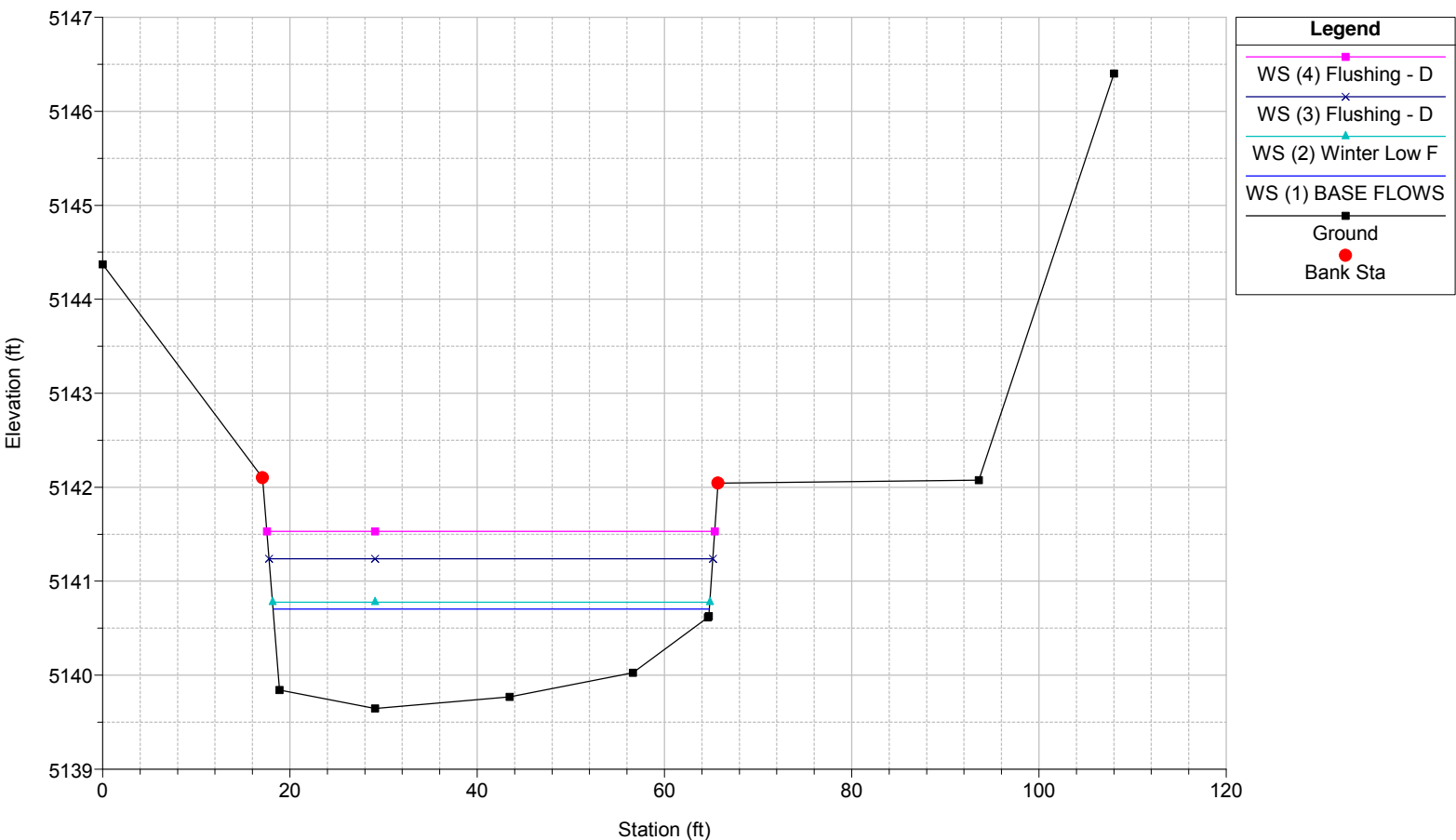
Poindexter Slough Plan: PS N=.04 9/5/2012
XS 55 - RIFFLE



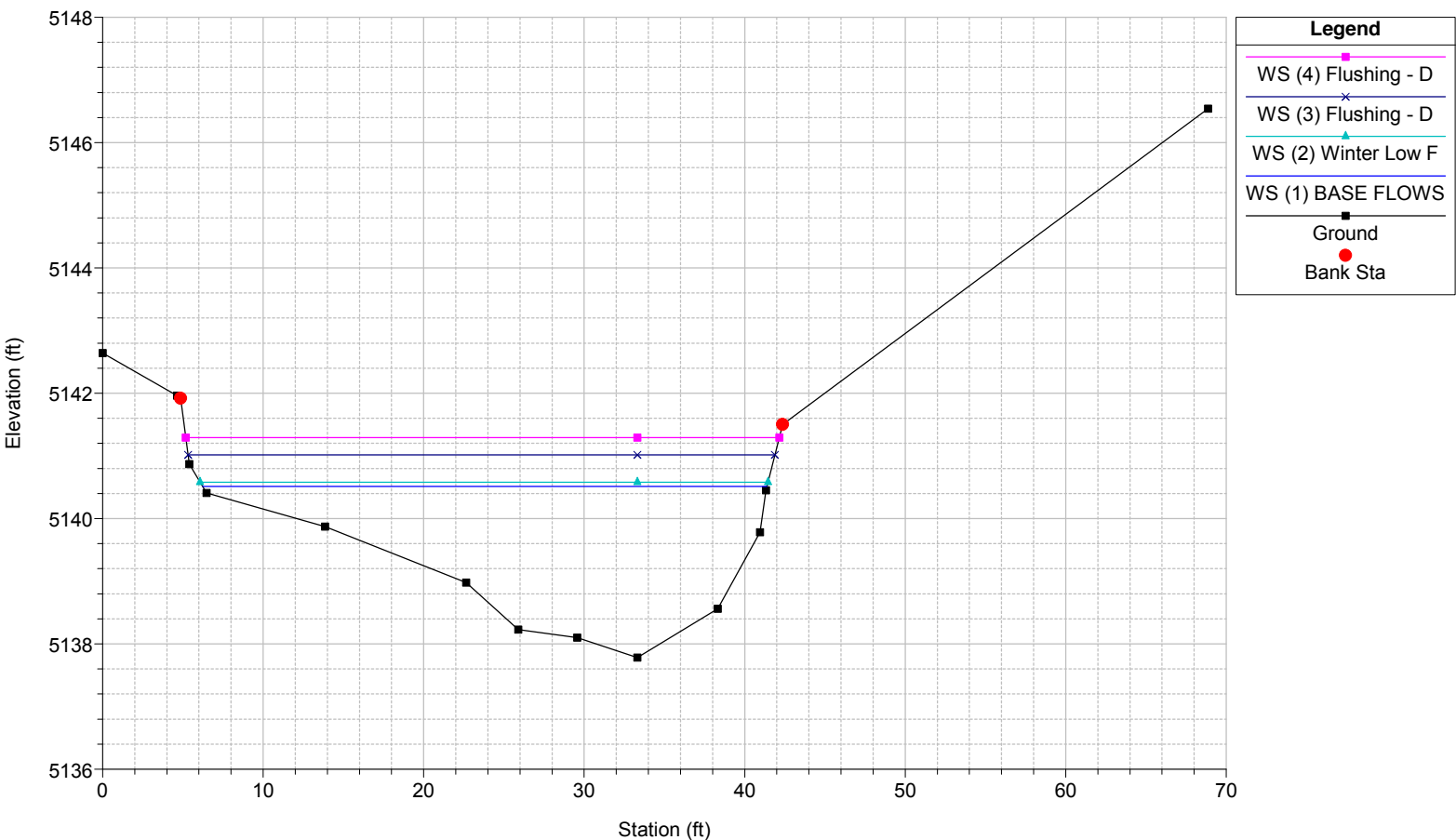
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XS - 56 - RIFFLE



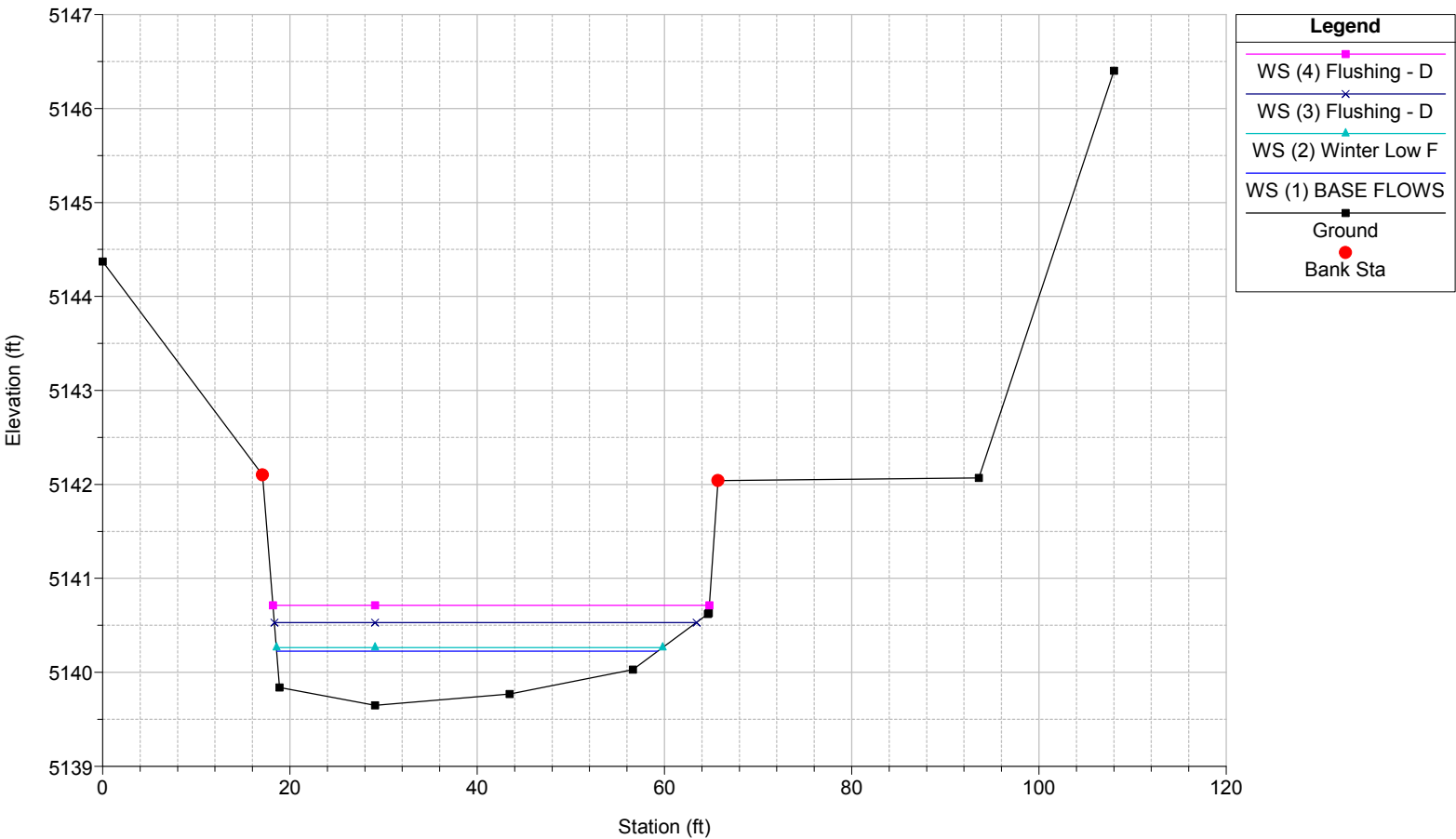
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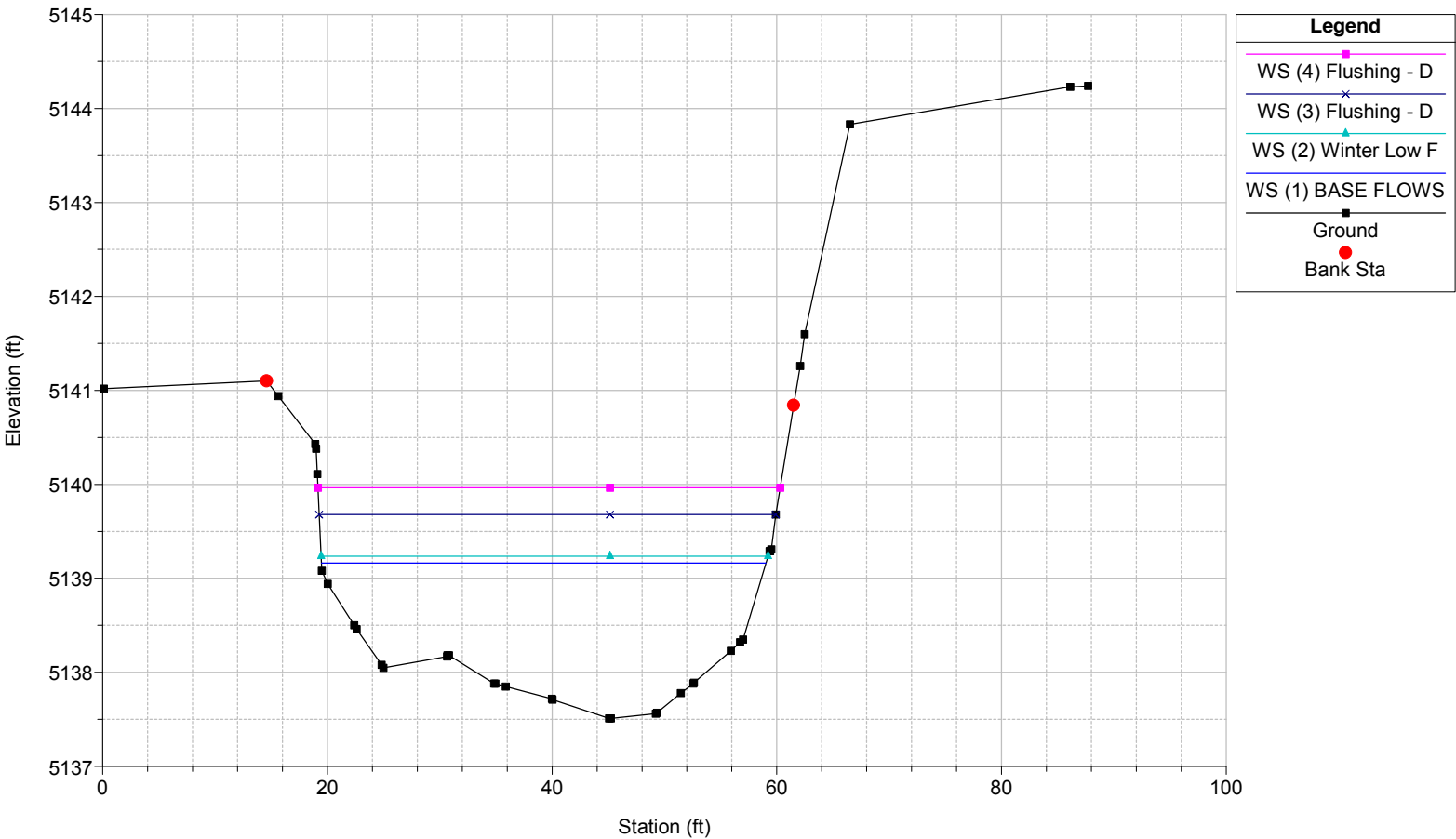
Poindexter Slough Plan: PS N=.04 9/5/2012
XS 58 - POOL



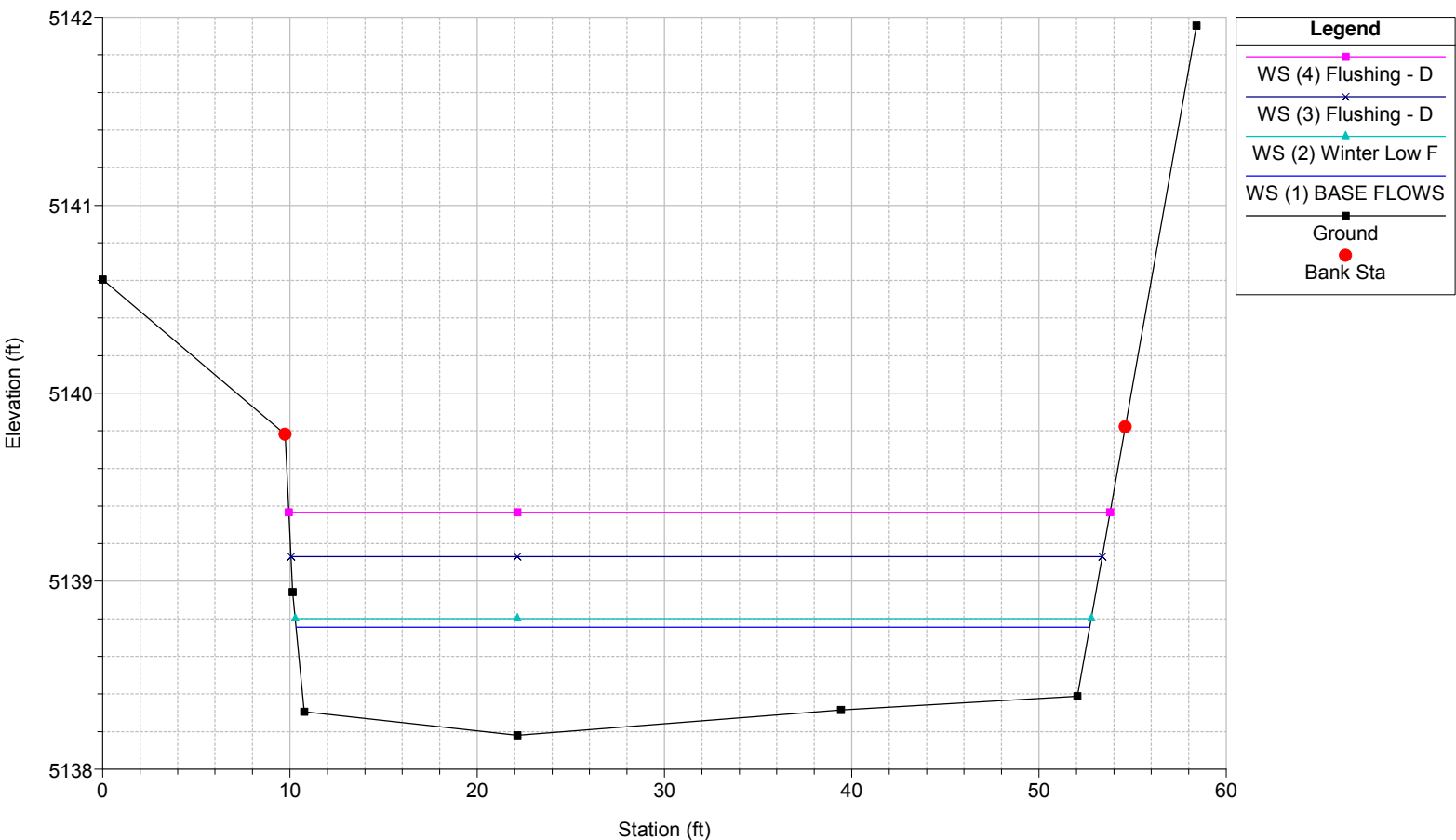
Poindexter Slough Plan: PS N=.04 9/5/2012
XS 59 - POOL



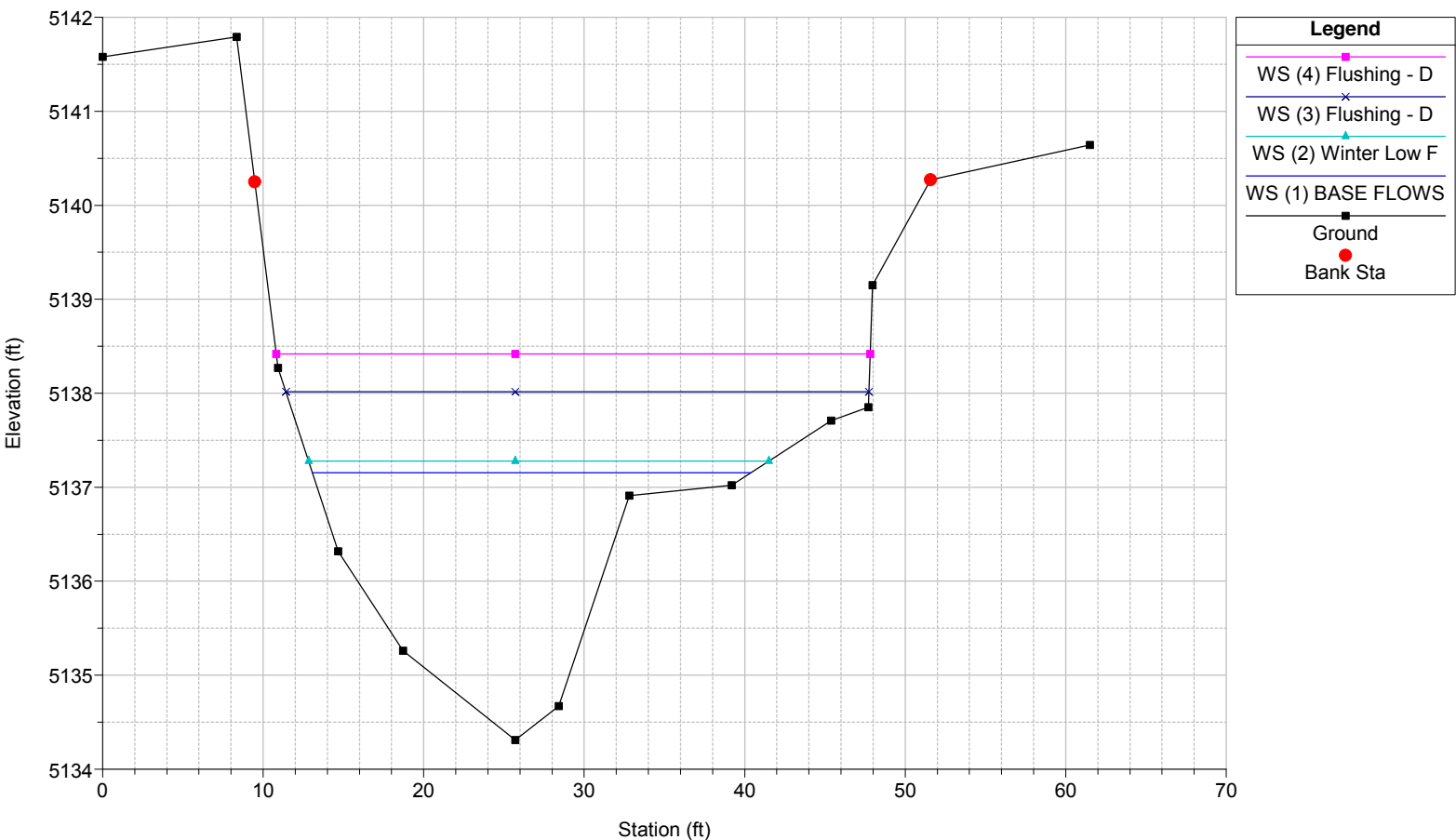
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XS 60 - POOL

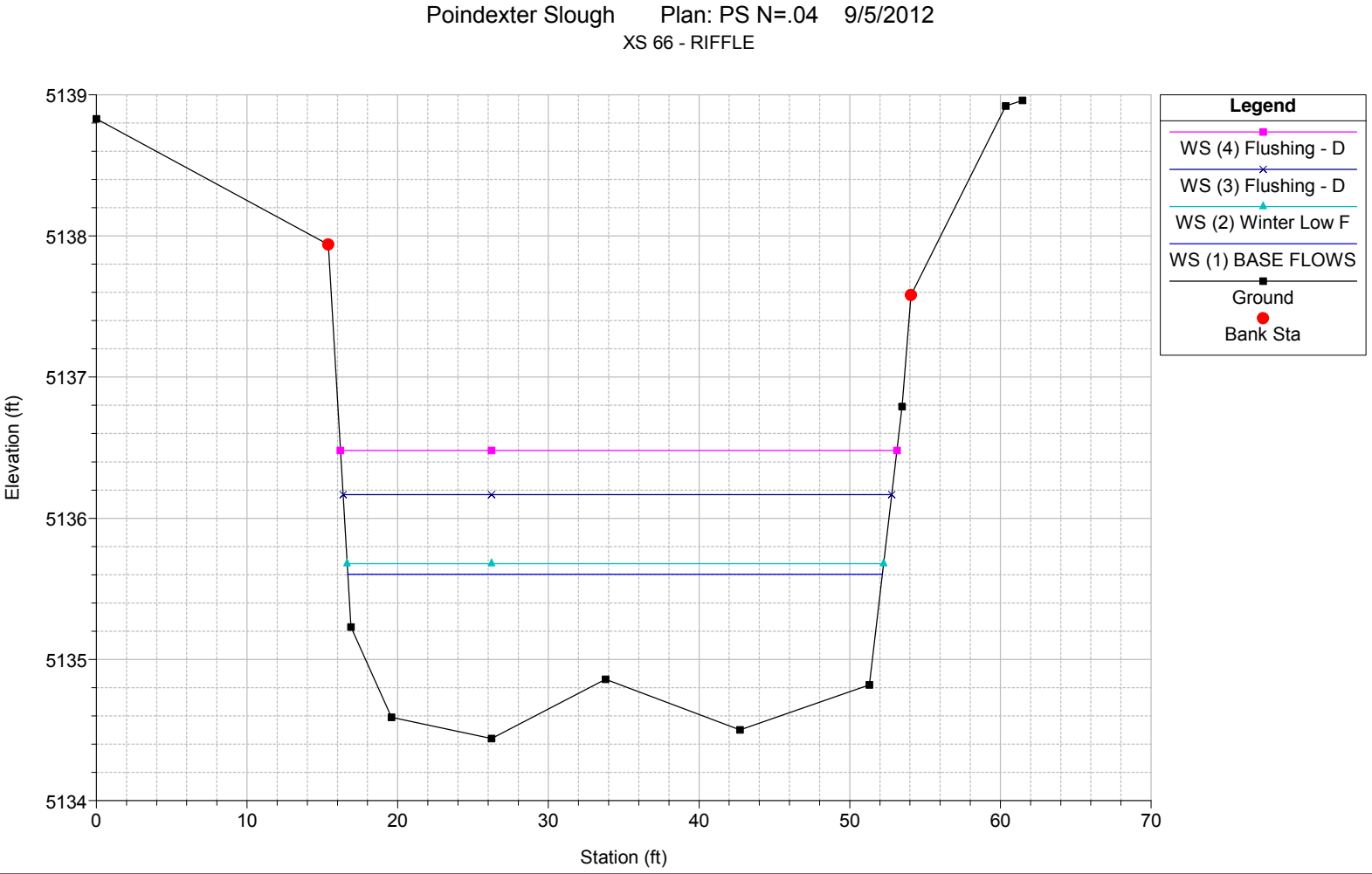
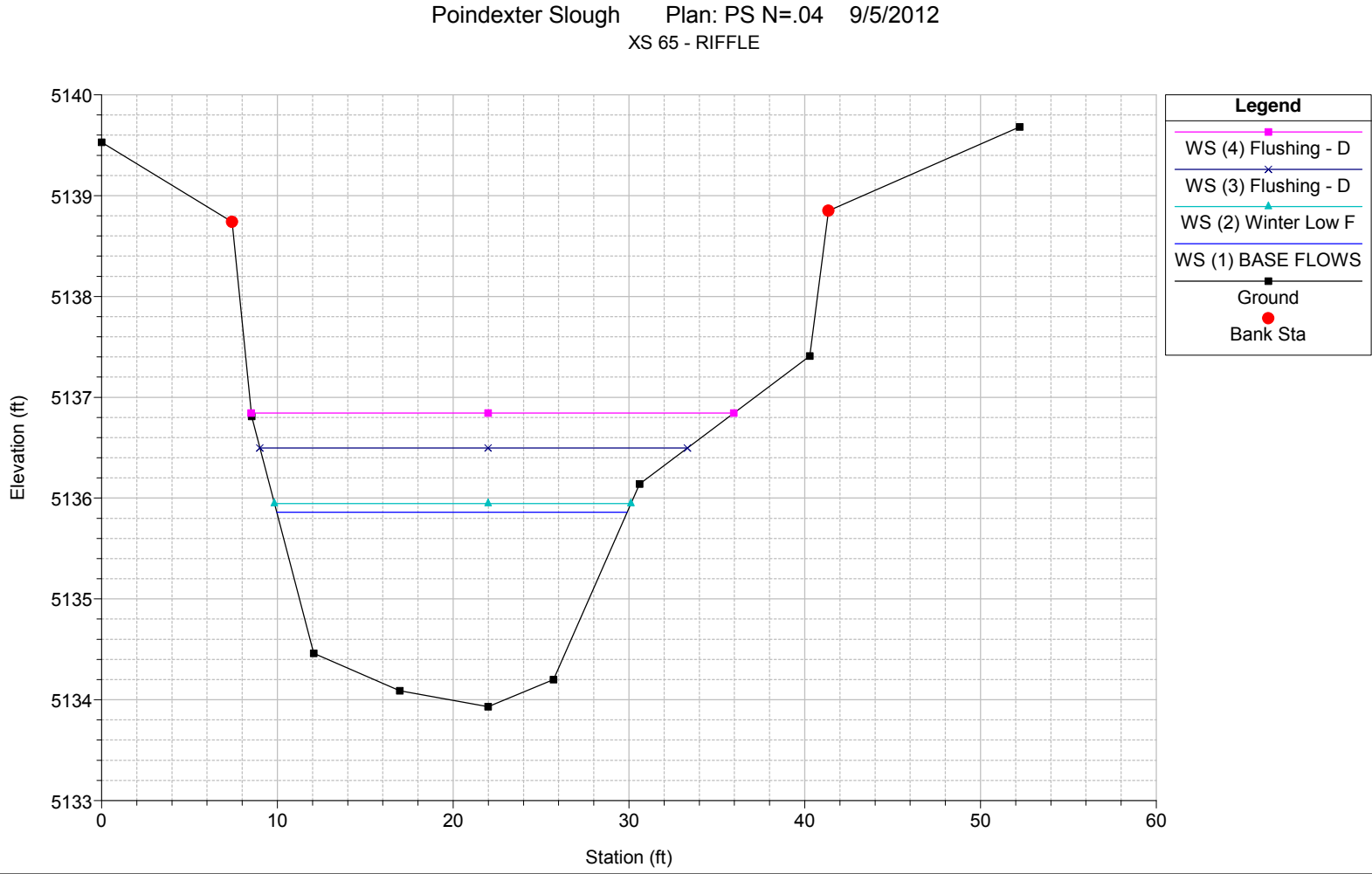
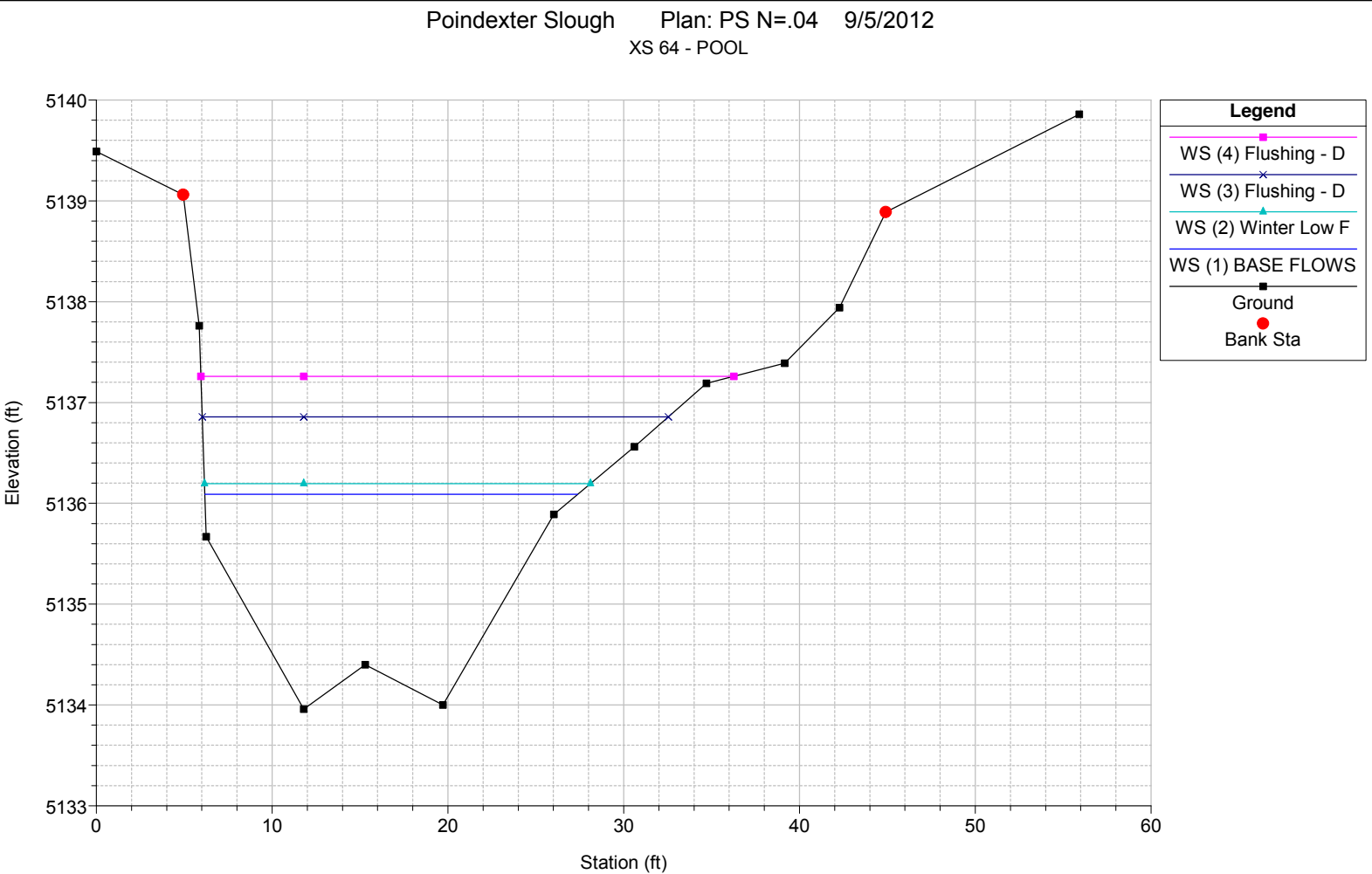
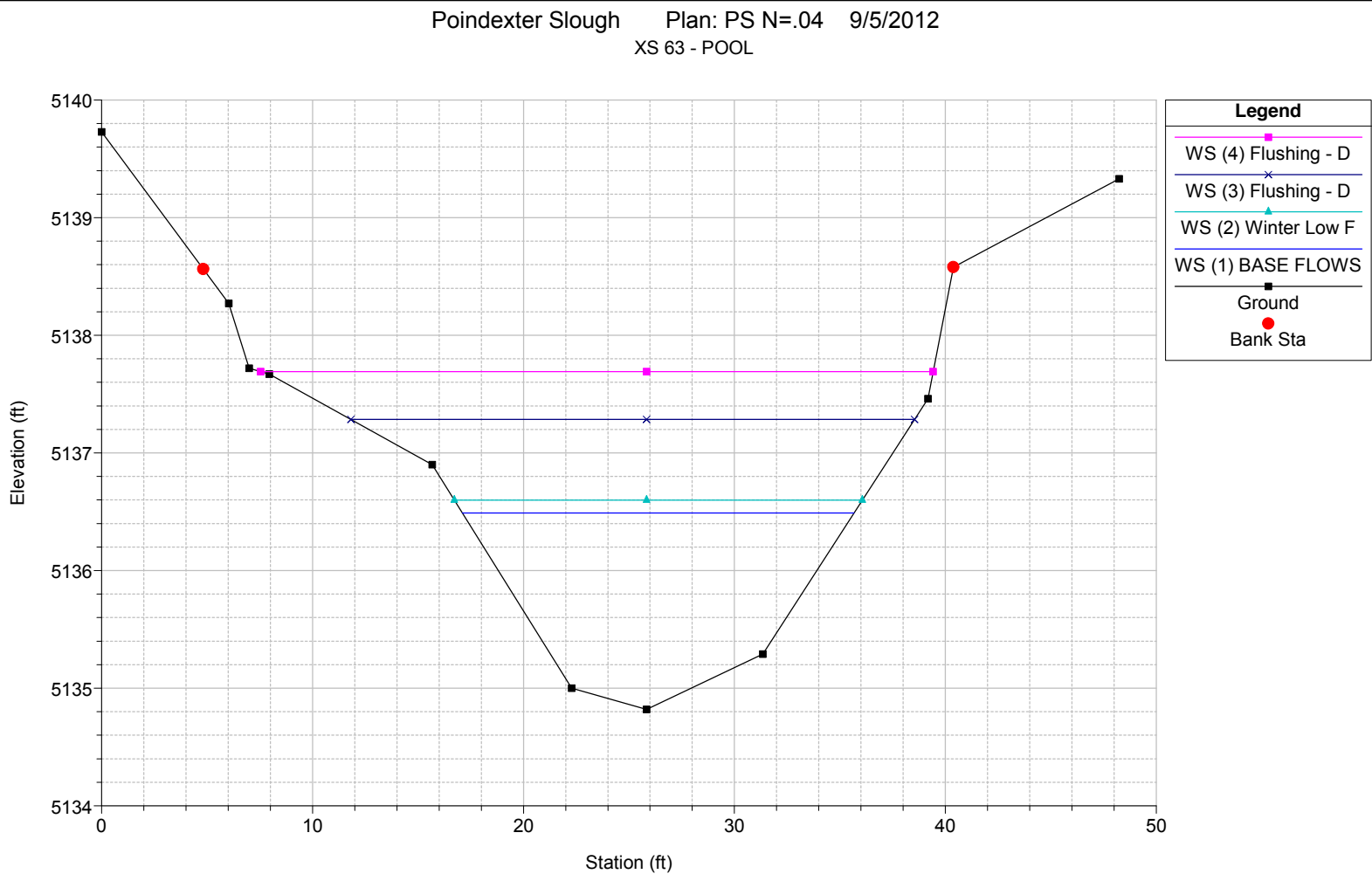


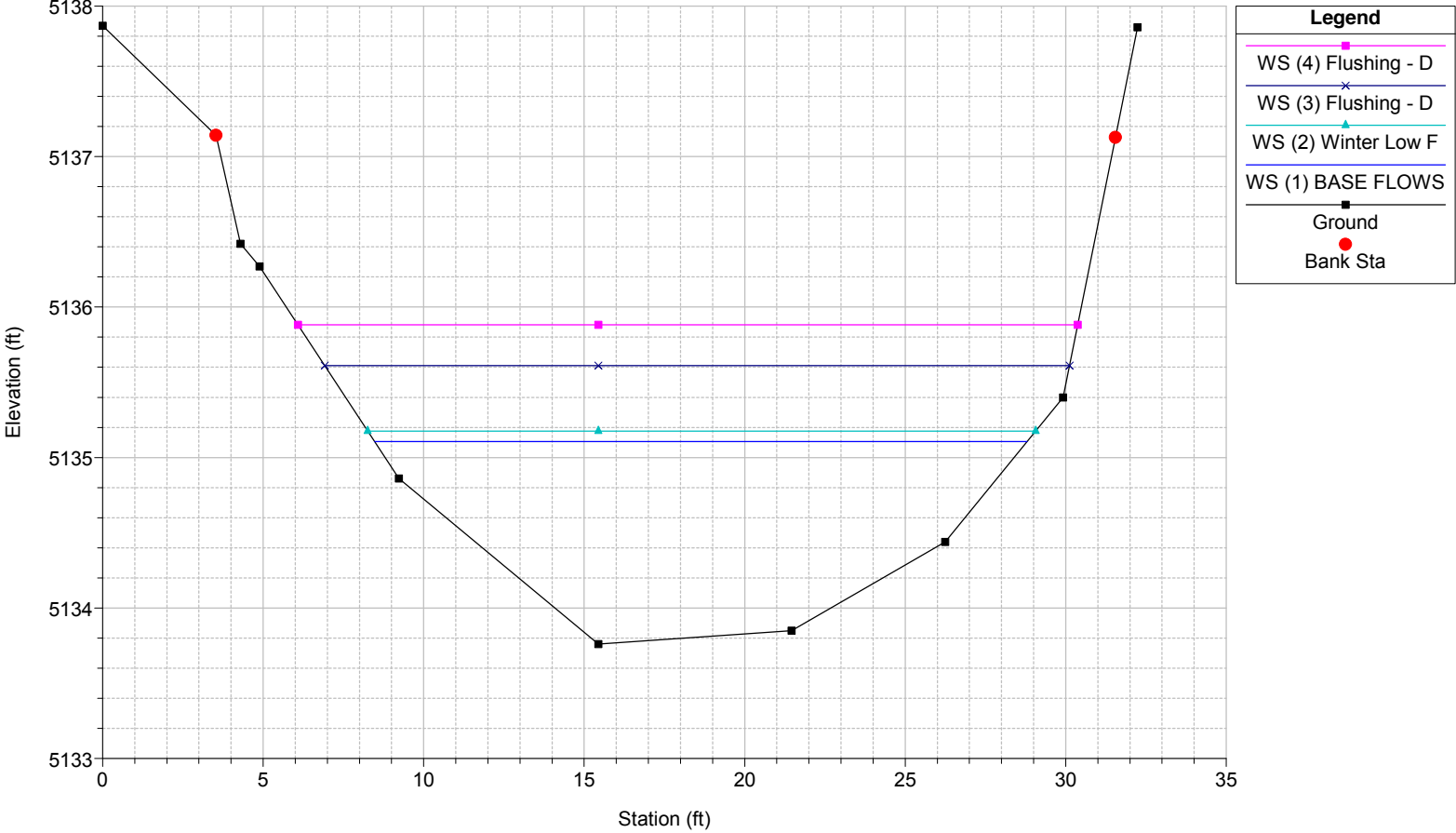
Poindexter Slough Plan: PS N=.04 9/5/2012
XS 61 - RIFFLE



Poindexter Slough Plan: PS N=.04 9/5/2012
XS 62 - POOL







Appendix D

Hydraulic Results at Riffle Cross Sections for Spawning Suitability

Spawning Suitability - Poindexter Slough HEC-RAS Output Table (Q=50 cfs Base Flow)

HecRas River Sta	Description	Reach	Cross Section	Q Total (cfs)	Max Chl Dpth (ft)	Vel Chnl (ft/s)
25072	Ditch	Reach 1	XS .1	50	2.97	2.76
24938	Ditch	Reach 1	XS .5	50	3.76	0.95
24687	Ditch	Reach 1	XS 1	50	2	2.03
23724	ditch	Reach 1	XS 3	50	2.56	1.03
23109	Riffle	Reach 2	XS 5	53.71	1.07	2.04
22027	Riffle	Reach 2	XS 8	57.49	1.66	1.36
21517	Riffle	Reach 2	XS 10	57.49	1.25	2.85
20469	Riffle	Reach 2	XS 12	57.49	1.29	1.84
19145	Riffle	Reach 2	XS 16	57.49	1.11	3.25
16651	Riffle	Reach 2	XS 22	61.54	1.17	1.91
16372	Riffle	Reach 2	XS 23	61.54	1.3	1.68
15794	Riffle	Reach 2	XS 24	74.66	0.92	1.99
15169	Riffle	Reach 2	XS 26	74.66	1.38	2.9
13630	Riffle	Reach 2	XS 30	74.66	1.33	1.85
12936	Riffle	Reach 3	XS 31	67.36	2.02	1.62
12582	Riffle	Reach 3	XS 32	67.36	1.93	0.79
11211	Riffle	Reach 3	XS 35	72.72	3.42	0.64
10541	Riffle	Reach 4	XS 37	37.03	0.89	1.94
10344	Riffle	Reach 4	XS 38	37.03	1.68	1.17
8892	Riffle	Reach 4	XS 41	37.03	1.89	1.18
7917	Riffle	Reach 4	XS 43	37.03	1.11	1.36
7383	Riffle	Reach 4	XS 44	37.03	1.24	1.36
6049	Riffle	Reach 4	XS 49	39.51	1.36	1.21
4635	Riffle	Reach 4	XS 52	39.51	1.15	1.29
4418	Riffle	Reach 4	XS 53	39.51	1.06	1.25
3262	Riffle	Reach 4	XS 56	42.3	1.23	0.97
2233	Riffle	Reach 4	XS 60	42.3	1.65	0.92
1876	Riffle	Reach 4	XS 61	42.3	0.57	2.13
525	Riffle	Reach 4	XS 65	42.3	1.93	1.48
300	Riffle	Reach 4	XS 66	42.3	1.16	1.28
22690	Riffle (Reference)	Reach 2	XS 7	53.71	0.95	2.17
19704	Riffle (Reference)	Reach 2	XS 14	57.49	0.95	2.13
18337	Riffle (Reference)	Reach 2	XS 18	61.54	0.99	2.75
14306	Riffle (Reference)	Reach 2	XS 28	74.66	0.98	2.43
6546	Riffle (Reference)	Reach 4	XS 47	39.51	0.99	1.84
3730	Riffle (Reference)	Reach 4	XS 55	39.51	1.18	1.71
2990	Riffle (Reference)	Reach 4	XS 57	42.3	1.06	1.11

	*Optimal Spawning (V = 1 - 2.3 ft/s, D > .5')
	*Suitable Spawning (V = .33 - 2.95 ft/s, D > .5')
	Unsuitable Spawning

*Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Brown Trout, revised. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.124). 65 pp. [First printed as: FWS/OBS-82/10.71, September 1984].

*Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp.

Spawning Suitability - Poindexter Slough HEC-RAS Output Table - Q=20 cfs at Upper Headgate (Low Flow)

HecRas River Sta	Description	Reach	Cross Section	Q Total (cfs)	Max Chl Dpth (ft)	Vel Chnl (ft/s)
300	Riffle	Reach 4	XS 66	48.15	1.24	1.35
525	Riffle	Reach 4	XS 65	48.15	2.02	1.58
1876	Riffle	Reach 4	XS 61	48.15	0.62	2.2
2233	Riffle	Reach 4	XS 60	48.15	1.72	0.98
2990	Riffle (Reference)	Reach 4	XS 57	48.15	1.13	1.16
3262	Riffle	Reach 4	XS 56	48.15	1.31	1.02
3730	Riffle (Reference)	Reach 4	XS 55	45.36	1.23	1.79
4418	Riffle	Reach 4	XS 53	45.36	1.15	1.28
4635	Riffle	Reach 4	XS 52	45.36	1.22	1.36
6049	Riffle	Reach 4	XS 49	45.36	1.46	1.22
6546	Riffle (Reference)	Reach 4	XS 47	45.36	1.07	1.91
7383	Riffle	Reach 4	XS 44	42.88	1.32	1.41
7917	Riffle	Reach 4	XS 43	42.88	1.19	1.45
8892	Riffle	Reach 4	XS 41	42.88	2	1.26
10344	Riffle	Reach 4	XS 38	42.88	1.78	1.21
10541	Riffle	Reach 4	XS 37	42.88	0.97	1.99
11211	Riffle	Reach 3	XS 35	42.72	3.5	0.37
12582	Riffle	Reach 3	XS 32	37.36	1.87	0.46
12936	Riffle	Reach 3	XS 31	37.36	1.81	1.11
13630	Riffle	Reach 2	XS 30	44.66	0.97	1.65
14306	Riffle (Reference)	Reach 2	XS 28	44.66	0.74	2.04
15169	Riffle	Reach 2	XS 26	44.66	1.09	2.49
15794	Riffle	Reach 2	XS 24	44.66	0.67	1.71
16372	Riffle	Reach 2	XS 23	31.54	0.99	1.26
16651	Riffle	Reach 2	XS 22	31.54	0.84	1.5
18337	Riffle (Reference)	Reach 2	XS 18	31.54	0.7	2.19
19145	Riffle	Reach 2	XS 16	27.49	0.82	2.63
19704	Riffle (Reference)	Reach 2	XS 14	27.49	0.62	1.69
20469	Riffle	Reach 2	XS 12	27.49	0.89	1.46
21517	Riffle	Reach 2	XS 10	27.49	0.91	2.4
22027	Riffle	Reach 2	XS 8	27.49	1.24	1.1
22690	Riffle (Reference)	Reach 2	XS 7	23.71	0.63	1.57
23109	Riffle	Reach 2	XS 5	23.71	0.66	1.7
23724	ditch	Reach 1	XS 3	20	2.07	0.65
24687	Ditch	Reach 1	XS 1	20	1.38	1.43
24938	Ditch	Reach 1	XS .5	20	3.07	0.53
25072	Ditch	Reach 1	XS .1	20	2.24	1.52

	Optimal Spawning (V = 1 - 2.3 ft/s, D > .5')
	Suitable Spawning (V = .33 - 2.95 ft/s, D > .5')
	Unsuitable Spawning

*Raleigh, R.F., L.D. Zuckerman, and P.C. Nelson. 1986. Habitat Suitability Index Models and Instream Flow Suitability Curves: Brown Trout, revised. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.124). 65 pp. [First printed as: FWS/OBS-82/10.71, September 1984].

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Appendix E

Incipient Motion Calculations for Base Flow and Flushing Flows

Project: Poindexter Slough Incipient Motion - 50 CFS at Headgate (Includes GW Inputs and 35 cfs canal withdrawal)

Engineer Date	TT 9/5/2012	Color Key: Red = manual input Green = HEC-RAS input Blue = calculated values
Suggested Input values:		
F* = Shield's pmtr. =	0.03 (gravel/stone bed) 0.047 (sand bed)	ST = stability factor = 1.0-1.2: Uniform flow, straight to mildly curving, Rc/W>30, wave and debris impact minimal 1.3-1.6: Gradually varied flow, moderate bend, 10<Rc/W<30, wave and debris impact moderate 1.6-2.0: Approaching rapidly varying flow, sharp bend, Rc/w<10, significant impact, high turbulence, uncertainty in parameters
Gs = sediment spec. grav. =	2.65	
gamma w = unit weight of water =	62.4	
gamma s = unit weight of sediment =	165.4	
theta = repose angle (deg) =	typically 36° (30°-45°), set to 1 for sizing bed material	Ct = turbulence coefficient = 0.86 for high turbulence 1.2 for low turbulence
phi = bank angle (deg) =	26.5 for 2:1, 33.7 for 1.5:1, set to 0 for sizing bed material	
Rc = bend radius of curvature =	10,000 for straight reach measured value for bend use bankfull top width when flow is over banks	FS = safety factor = 1.0 (minimum) in straight reaches 1.25 in bends, high energy areas, and at abrupt changes in roughness 1.5 (minimum) for rounded stone
W = top width =		
Kb = bend factor = (Kb is automatically calculated)	1.0 for straight section 1.1-2.0 for bend (see attached Kb chart)	Cth = thickness coefficient = 1.0 when the thicker of (1"D100) and (1.5"D50) is used as RR blanket thickness

INPUT					
F*	Gs	gamma w	gamma s	theta	phi
0.03	2.65	62.4	165.4	36	26.5
g	Ct	Cth			
32.2	0.86	1			

Kb = 1.0 in columns below
on straight reaches

Calculated K = 0.65

INPUT from HEC-RAS										Bends Only				All	
XS #	Q	A	Pw	d max	V ave	Se	Shear	W	Rc	RoW	Kb	St	FS		
XS 1	50	19.71	13.62	2.97	2.76	0.0023	0.28	40	10000	250	1.00	1	1		
XS 5	50	53.57	25.3	3.76	0.95	0.0002	0.03	40	10000	250	1.00	1	1		
XS 1	50	24.67	19.16	2	2.03	0.0021	0.17	40	10000	250	1.00	1	1		
XS 2	50	18.07	21.02	1.13	2.77	0.0068	0.36	40	10000	250	1.00	1	1		
XS 3	50	48.55	38.45	2.56	1.03	0.0006	0.04	40	10000	250	1.00	1	1		
XS 4	55.78	23.85	30.74	1.71	2.34	0.0056	0.27	40	10000	250	1.00	1	1		
XS 5	53.71	26.36	32.06	1.07	2.04	0.0039	0.2	40	10000	250	1.00	1	1		
XS 6	53.71	28.85	27.48	1.79	1.86	0.0024	0.15	40	10000	250	1.00	1	1		
XS 7	53.71	24.74	30.82	0.95	2.17	0.0046	0.23	40	10000	250	1.00	1	1		
XS 8	57.49	42.4	42.37	1.66	1.36	0.0013	0.08	40	10000	250	1.00	1	1		
XS 9	57.49	52.73	33.06	2.29	1.09	0.0005	0.05	40	10000	250	1.00	1	1		
XS 10	57.49	20.18	26.36	1.25	2.85	0.0063	0.41	40	10000	250	1.00	1	1		
XS 11	57.49	36.5	25.71	2.39	1.58	0.0011	0.1	40	10000	250	1.00	1	1		
XS 12	57.49	31.18	32.76	1.29	1.84	0.0026	0.16	40	10000	250	1.00	1	1		
XS 13	57.49	58.8	39.55	3.27	0.98	0.0004	0.04	40	10000	250	1.00	1	1		
XS 14	57.49	26.98	32.79	0.95	2.13	0.0043	0.22	40	10000	250	1.00	1	1		
XS 15	57.49	59.85	54.61	2.81	0.98	0.0005	0.04	40	10000	250	1.00	1	1		
XS 16	57.49	19.09	37.59	1.11	3.25	0.0102	0.53	40	10000	250	1.00	1	1		
XS 17	57.49	79.65	51.21	3.7	0.72	0.0002	0.02	40	10000	250	1.00	1	1		
XS 18	61.54	22.39	28.19	0.99	2.75	0.0074	0.37	40	10000	250	1.00	1	1		
XS 19	61.54	28.1	23.48	1.87	2.19	0.0027	0.2	40	10000	250	1.00	1	1		
XS 20	61.54	25.29	19.03	1.99	2.43	0.0029	0.24	40	10000	250	1.00	1	1		
XS 21	61.54	39	29.17	2.28	1.58	0.0012	0.1	40	10000	250	1.00	1	1		
XS 22	61.54	32.23	35.19	1.17	1.91	0.0030	0.17	40	10000	250	1.00	1	1		
XS 23	61.54	36.64	38.09	1.3	1.68	0.0022	0.13	40	10000	250	1.00	1	1		
XS 24	74.66	37.61	46.6	0.92	1.99	0.0038	0.19	40	10000	250	1.00	1	1		
XS 25	74.66	49.33	33.22	2.23	1.51	0.0010	0.09	40	10000	250	1.00	1	1		
XS 26	74.66	25.79	27.26	1.38	2.9	0.0065	0.39	40	10000	250	1.00	1	1		
XS 27	74.66	38.74	29.33	2.25	1.93	0.0019	0.15	40	10000	250	1.00	1	1		
XS 28	74.66	36.86	35.98	0.98	2.43	0.0054	0.28	40	10000	250	1.00	1	1		
XS 29	74.66	51.25	44.73	2.31	1.46	0.0013	0.09	40	10000	250	1.00	1	1		
XS 30	74.66	40.42	40.41	1.33	1.85	0.0025	0.15	40	10000	250	1.00	1	1		
XS 31	67.36	41.69	40.25	2.02	1.62	0.0018	0.12	40	10000	250	1.00	1	1		
XS 32	67.36	85.63	62.09	1.93	0.79	0.0003	0.03	40	10000	250	1.00	1	1		
XS 33	67.36	90.27	47.02	3.68	0.75	0.0002	0.02	40	10000	250	1.00	1	1		
XS 34	67.36	91.71	42.83	3.95	0.73	0.0001	0.02	40	10000	250	1.00	1	1		
XS 35	72.72	112.79	45.32	3.42	0.84	0.0001	0.01	40	10000	250	1.00	1	1		
XS 35.1	37.03	55.58	27.33	3.07	0.67	0.0001	0.02	40	10000	250	1.00	1	1		
XS 35.3	37.03	9.08	18.42	0.55	4.08	0.0369	0.95	40	10000	250	1.00	1	1		
XS 35.4	37.03	20.09	29.87	1.33	1.84	0.0042	0.18	40	10000	250	1.00	1	1		
XS 36	37.03	22.8	20.2	1.81	1.62	0.0016	0.11	40	10000	250	1.00	1	1		
XS 37	37.03	19.05	29.52	0.89	1.94	0.0049	0.2	40	10000	250	1.00	1	1		
XS 38	37.03	31.76	36.11	1.68	1.17	0.0012	0.06	40	10000	250	1.00	1	1		
XS 39	37.03	28	26.77	1.54	1.42	0.0015	0.09	40	10000	250	1.00	1	1		
XS 40	37.03	21.32	25.6	1.83	1.69	0.0025	0.14	40	10000	250	1.00	1	1		
XS 41	37.03	31.42	23.69	1.89	1.18	0.0007	0.06	40	10000	250	1.00	1	1		
XS 42	37.03	50.18	35.2	2.48	0.74	0.0002	0.02	40	10000	250	1.00	1	1		
XS 43	37.03	27.16	32.65	1.11	1.36	0.0017	0.09	40	10000	250	1.00	1	1		
XS 44	37.03	27.27	36.16	1.24	1.36	0.0019	0.09	40	10000	250	1.00	1	1		
XS 45	37.03	55.95	37.55	2.36	0.66	0.0002	0.02	40	10000	250	1.00	1	1		
XS 46	37.03	47.98	33.71	2.36	0.77	0.0003	0.02	40	10000	250	1.00	1	1		
XS 47	39.51	21.43	28.12	0.99	1.84	0.0035	0.17	40	10000	250	1.00	1	1		
XS 48	39.51	29.39	22.63	1.99	1.34	0.0009	0.07	40	10000	250	1.00	1	1		
XS 49	39.51	32.55	46.25	1.36	1.21	0.0017	0.07	40	10000	250	1.00	1	1		
XS 50	39.51	30.34	25.14	2.22	1.3	0.0010	0.07	40	10000	250	1.00	1	1		
XS 51	39.51	65.18	34.39	2.87	0.61	0.0001	0.01	40	10000	250	1.00	1	1		
XS 52	39.51	30.68	38.44	1.15	1.29	0.0016	0.08	40	10000	250	1.00	1	1		
XS 53	39.51	31.57	46.53	1.06	1.25	0.0019	0.08	40	10000	250	1.00	1	1		
XS 54	39.51	35.01	33.23	2.03	1.13	0.0009	0.06	40	10000	250	1.00	1	1		
XS 55	39.51	23.16	43.79	1.18	1.71	0.0048	0.16	40	10000	250	1.00	1	1		
XS 56	42.3	43.77	48.79	1.23	0.97	0.0008	0.04	40	10000	250	1.00	1	1		
XS 57	42.3	38.08	47.08	1.06	1.11	0.0012	0.06	40	10000	250	1.00	1	1		
XS 58	42.3	52.18	36.09	2.73	0.81	0.0003	0.03	40	10000	250	1.00	1	1		
XS 59	42.3	16.86	40.88	0.57	2.51	0.0148	0.38	40	10000	250	1.00	1	1		
XS 60	42.3	46.02	39.93	1.65	0.92	0.0005	0.04	40	10000	250	1.00	1	1		
XS 61	42.3	19.89	42.67	0.57	2.13	0.0091	0.26	40	10000	250	1.00	1	1		
XS 62	42.3	37.2	28.28	2.84	1.14	0.0007	0.05	40	10000	250	1.00	1	1		
XS 63	42.3	19.93	18.86	1.67	2.12	0.0031	0.2	40	10000	250	1.00	1	1		
XS 64	42.3	29.47	22.15	2.13	1.44	0.0010	0.08	40	10000	250	1.00	1	1		
XS 65	42.3	28.66	20.69	1.93	1.48	0.0010	0.09	40	10000	250	1.00	1	1		
XS 66	42.3	33.04	36.11	1.76	1.28	0.0013	0.08	40	10000	250	1.00	1	1		
XS 67	50.4	18.12	20.58	1.35	2.75	0.0064	0.36	40	10000	250	1.00	1	1		

Mobile size (inches)										
XS #	Shields	ASCE	Cal DOH	USBR	Irbach	ACOE	Cal DOT	HEC-11	Average*	
XS 1	1.1	0.7	0.8	1.2	1.2	0.5	0.3	0.2	0.75	
XS 5	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.08	
XS 1	0.7	0.4	0.4	0.6	0.6	0.3	0.2	0.1	0.41	
XS 2	1.4	0.7	0.8	1.2	1.2	0.6	0.3	0.3	0.83	
XS 3	1.4	0.7	0.8	1.2	1.2	0.6	0.3	0.3	0.83	
XS 4	0.2	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.10	
XS 5	1.0	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.58	
XS 6	0.8	0.4	0.5	0.6	0.6	0.3	0.2	0.1	0.44	
XS 7	0.6	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.35	
XS 8	0.9	0.5	0.5	0.7	0.7	0.4	0.2	0.2	0.51	
XS 9	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.18	
XS 10	0.2	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.11	
XS 11	1.6	0.8	0.9	1.3	1.2	0.7	0.3	0.4	0.89	
XS 12	0.4	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 13	0.6	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.35	
XS 14	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.09	
XS 15	0.9	0.4	0.5	0.7	0.7	0.4	0.2	0.2	0.49	
XS 16	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.09	
XS 17	2.1	1.0	1.2	1.7	1.6	1.0	0.4	0.6	1.18	
XS 18	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 19	1.4	0.7	0.8	1.2	1.2	0.7	0.3	0.4	0.83	
XS 20	0.8	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.48	
XS 21	0.9	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.60	
XS 22	0.4	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 23	0.7	0.4	0.4	0.6	0.6	0.3	0.1	0.1	0.38	
XS 24	0.5	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.28	
XS 25	0.7	0.4	0.4	0.6	0.6	0.3	0.2	0.1	0.42	
XS 26	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.22	
XS 27	1.5	0.8	0.9	1.3	1.3	0.7	0.3	0.4	0.90	
XS 28	0.6	0.4	0.4	0.6	0.6	0.2	0.1	0.1	0.37	
XS 29	1.1	0.6	0.6	0.9	0.9	0.5	0.2	0.3	0.64	
XS 30	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.21	
XS 31	0.6	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.35	
XS 32	0.5	0.3	0.3	0.4	0.4	0.1	0.1	0.1	0.26	
XS 33	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 34	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 35	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 35.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.03	
XS 35.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.04	
XS 35.4	3.7	1.6	1.8	2.7	2.5	2.0	0.7	1.6	2.08	
XS 36	0.7	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.36	
XS 37	0.4	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.26	
XS 38	0.8	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.60	
XS 39	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.13	
XS 40	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.20	
XS 41	0.5	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.29	
XS 42	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.13	
XS 43	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 44	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 45	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 46	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 47	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.05	
XS 48	0.7	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.36	
XS 49	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 50	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 51	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.16	
XS 52	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.03	
XS 53	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 54	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 55	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.13	
XS 56	0.6	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.31	
XS 57	0.2	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.09	
XS 58	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.0	0.13	
XS 59	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 60	1.5	0.6	0.7	1.0	1.0	0.6	0.3	0.4	0.74	
XS 61	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.08	
XS 62	1.0	0.5	0.4	0.7	0.7	0.3	0.2	0.2	0.50	
XS 63	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.12	
XS 64	0.8	0.4	0.5	0.7	0.7	0.3	0.2	0.1	0.46	
XS 65	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.20	
XS 66	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 67	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	

Project: Poindexter Slough Incipient Motion - 100 CFS at Headgate (Includes GW Inputs and 35 cfs canal withdrawal)

Engineer Date	TT 9/5/2012	Color Key: Red = manual input Green = HEC-RAS input Blue = calculated values
Suggested Input values:		
F* = Shield's pmt. =	0.03 (gravel/stone bed) 0.047 (sand bed)	ST = stability factor = 1.0-1.2: Uniform flow, straight to mildly curving, Rc/W>30, wave and debris impact minimal 1.3-1.6: Gradually varied flow, moderate bend, 10<Rc/W<30, wave and debris impact moderate 1.6-2.0: Approaching rapidly varying flow, sharp bend, Rc/w<10, significant impact, high turbulence, uncertainty in parameters
Gs = sediment spec. grav. =	2.65	
gamma w = unit weight of water =	62.4	
gamma s = unit weight of sediment =	165.4	
theta = repose angle (deg) =	typically 36° (30°-45°), set to 1 for sizing bed material	Ct = turbulence coefficient = 0.86 for high turbulence 1.2 for low turbulence
phi = bank angle (deg) =	26.5 for 2:1, 33.7 for 1.5:1, set to 0 for sizing bed material	
Rc = bend radius of curvature =	10,000 for straight reach measured value for bend use bankfull top width when flow is over banks	FS = safety factor = 1.0 (minimum) in straight reaches 1.25 in bends, high energy areas, and at abrupt changes in roughness 1.5 (minimum) for rounded stone
W = top width =		
Kb = bend factor = (Kb is automatically calculated)	1.0 for straight section 1.1-2.0 for bend (see attached Kb chart)	Cth = thickness coefficient = 1.0 when the thicker of (1"D100) and (1.5"D50) is used as RR blanket thickness

INPUT					
F*	Gs	gamma w	gamma s	theta	phi
0.03	2.65	62.4	165.4	36	26.5
g	Ct	Cth		Kb = 1.0 in columns below on straight reaches	
32.2	0.86	1			

Calculated K = 0.65

INPUT from HEC-RAS									
XS #	Q	A	Pw	d max	V ave	Se	Shear	W	Rc
XS 1	100	28.16	17.19	3.74	4.14	0.0038	0.57	40	10000
XS 5	100	71.84	27.84	4.49	1.45	0.0003	0.07	40	10000
XS 1	100	37.12	21.33	2.64	2.69	0.0025	0.27	40	10000
XS 2	100	28.39	22.45	1.62	3.52	0.0066	0.52	40	10000
XS 3	100	68.14	39.71	3.05	1.07	0.0008	0.08	40	10000
XS 4	105.78	36.13	37.09	2.1	2.94	0.0055	0.38	40	10000
XS 5	103.71	43.35	35.54	1.59	2.39	0.0032	0.24	40	10000
XS 6	103.71	44.79	33.98	2.32	2.32	0.0027	0.22	40	10000
XS 7	107.49	38.06	33.15	1.38	2.72	0.0045	0.32	40	10000
XS 8	107.49	65	44.11	2.19	1.65	0.0012	0.11	40	10000
XS 9	107.49	69.68	34.63	2.81	1.54	0.0007	0.08	40	10000
XS 10	107.49	32.67	32.14	1.66	3.29	0.0077	0.49	40	10000
XS 11	107.49	53.36	29.72	3.02	2.01	0.0013	0.15	40	10000
XS 12	107.49	46.89	33.79	1.79	2.29	0.0025	0.21	40	10000
XS 13	107.49	78.4	40.78	3.78	1.37	0.0006	0.07	40	10000
XS 14	107.49	40.2	33.84	1.36	2.67	0.0041	0.31	40	10000
XS 15	107.49	83.5	49.68	3.38	1.36	0.0006	0.07	40	10000
XS 16	107.49	32.3	42.36	1.44	3.81	0.0104	0.65	40	10000
XS 17	107.49	108.5	56.58	4.23	0.99	0.0003	0.04	40	10000
XS 18	111.54	33.45	33.28	1.39	3.36	0.0068	0.49	40	10000
XS 19	111.54	55.47	25.96	2.46	2.86	0.0025	0.27	40	10000
XS 20	111.54	36.32	23.4	2.53	3.18	0.0033	0.37	40	10000
XS 21	111.54	56.06	40.88	2.79	2.08	0.0014	0.16	40	10000
XS 22	111.54	46.68	37.43	1.58	2.4	0.0029	0.24	40	10000
XS 23	111.54	52.07	53.22	1.67	2.19	0.0025	0.2	40	10000
XS 24	124.66	55.47	59.24	1.29	2.3	0.0032	0.23	40	10000
XS 25	124.66	64.73	38.06	2.88	1.94	0.0012	0.14	40	10000
XS 26	124.66	37.38	36.24	1.77	3.41	0.0059	0.48	40	10000
XS 27	124.66	52.93	32.75	2.72	2.36	0.0021	0.21	40	10000
XS 28	124.66	43.24	36.87	1.33	2.67	0.0050	0.36	40	10000
XS 29	124.66	70.08	46.57	2.73	1.78	0.0013	0.12	40	10000
XS 30	124.66	55.81	41.55	1.72	2.23	0.0024	0.2	40	10000
XS 31	117.36	66.75	42.11	2.64	1.76	0.0012	0.12	40	10000
XS 32	117.36	130.77	65.12	2.67	0.9	0.0002	0.03	40	10000
XS 33	117.36	125.22	51.04	4.42	0.94	0.0002	0.03	40	10000
XS 34	117.36	122.63	46.42	4.68	0.96	0.0002	0.03	40	10000
XS 35	122.72	147.33	55.56	4.12	0.85	0.0001	0.02	40	10000
XS 35.1	92.92	75.35	30.6	3.78	1.23	0.0003	0.05	40	10000
XS 35.3	92.92	17.21	19.78	0.99	5.4	0.0254	1.38	40	10000
XS 35.4	92.92	46.15	38.46	2.06	2.01	0.0023	0.17	40	10000
XS 36	92.92	37.99	25.11	2.57	2.46	0.0021	0.23	40	10000
XS 37	92.92	43.22	49.22	1.52	2.15	0.0040	0.22	40	10000
XS 38	92.92	58.42	38.48	2.41	1.59	0.0011	0.1	40	10000
XS 39	92.92	46.78	30.98	2.28	1.99	0.0017	0.16	40	10000
XS 40	92.92	46.34	35.28	2.62	2.01	0.0020	0.17	40	10000
XS 41	92.92	52.25	27.25	2.74	1.76	0.0010	0.12	40	10000
XS 42	92.92	77.25	38.4	3.23	1.2	0.0004	0.05	40	10000
XS 43	92.92	47.43	34.97	1.72	1.96	0.0019	0.16	40	10000
XS 44	92.92	52.42	38.59	1.93	1.77	0.0015	0.13	40	10000
XS 45	92.92	85.39	41.99	3.13	1.09	0.0003	0.04	40	10000
XS 46	92.92	74.13	38.76	3.11	1.25	0.0004	0.06	40	10000
XS 47	95.4	41.76	32.67	1.66	2.28	0.0027	0.22	40	10000
XS 48	95.4	47.85	29.84	2.74	2.01	0.0013	0.15	40	10000
XS 49	95.4	69.18	48.86	2.15	1.38	0.0009	0.08	40	10000
XS 50	95.4	35.14	33.67	3.06	1.73	0.0011	0.11	40	10000
XS 51	95.4	87.23	36.09	3.57	1.09	0.0003	0.04	40	10000
XS 52	95.4	52.76	39.7	1.73	1.81	0.0016	0.13	40	10000
XS 53	95.4	63.59	50.27	1.73	1.5	0.0012	0.09	40	10000
XS 54	95.4	61.2	47.62	2.72	1.56	0.0013	0.1	40	10000
XS 55	95.4	41.49	45.05	1.6	2.3	0.0043	0.25	40	10000
XS 56	98.19	72.08	50.06	1.82	1.36	0.0008	0.07	40	10000
XS 57	98.19	65.32	48.52	1.64	1.5	0.0011	0.09	40	10000
XS 58	98.19	71.99	37.99	3.28	1.36	0.0006	0.07	40	10000
XS 59	98.19	31.34	45.88	0.91	3.13	0.0118	0.5	40	10000
XS 60	98.19	68.87	41.68	2.22	1.43	0.0008	0.08	40	10000
XS 61	98.19	37.81	44.04	0.99	2.6	0.0060	0.32	40	10000
XS 62	98.19	67.39	37.89	3.77	1.46	0.0007	0.08	40	10000
XS 63	98.19	36.28	28.24	2.53	2.5	0.0029	0.25	40	10000
XS 64	98.19	49.57	28.65	2.96	1.98	0.0014	0.15	40	10000
XS 65	98.19	43.95	25.91	2.63	2.23	0.0018	0.19	40	10000
XS 66	98.19	55.15	37.73	1.78	1.76	0.0014	0.13	40	10000
XS 67	106.29	30.42	23.87	1.9	3.49	0.0064	0.51	40	10000

Mobile size (inches)										
XS #	Shields	ASCE	Cal DOH	USBR	Irbach	ACOE	Cal DOT	HEC-11	Average*	
XS 1	2.2	1.7	1.9	2.7	2.6	1.3	0.7	0.6	1.72	Min
XS 5	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	Max
XS 1	1.0	0.7	0.8	1.1	1.1	0.5	0.3	0.2	0.72	
XS 2	2.0	1.2	1.4	2.0	1.9	1.1	0.5	0.6	1.32	
XS 3	2.0	1.2	1.4	2.0	1.9	1.1	0.5	0.6	1.32	
XS 4	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.20	
XS 5	1.5	0.8	0.9	1.4	1.3	0.6	0.3	0.3	0.90	
XS 6	0.9	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.59	
XS 7	0.9	0.5	0.6	0.8	0.8	0.3	0.2	0.1	0.54	
XS 8	1.2	0.7	0.8	1.2	1.1	0.6	0.3	0.3	0.78	
XS 9	0.4	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.27	
XS 10	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.22	
XS 11	1.9	1.0	1.2	1.7	1.7	0.9	0.4	0.5	1.16	
XS 12	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 13	0.5	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.53	
XS 14	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.18	
XS 15	1.2	0.7	0.8	1.1	1.1	0.6	0.3	0.3	0.75	
XS 16	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 17	2.5	1.4	1.6	2.3	2.2	1.4	0.6	0.8	1.60	
XS 18	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.09	
XS 19	1.9	1.1	1.2	1.8	1.7	1.0	0.5	0.6	1.22	
XS 20	1.0	0.7	0.8	1.1	1.1	0.5	0.3	0.2	0.71	
XS 21	1.4	1.0	1.1	1.6	1.5	0.7	0.4	0.3	1.02	
XS 22	0.6	0.4	0.5	0.7	0.7	0.3	0.2	0.1	0.42	
XS 23	0.9	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.58	
XS 24	0.8	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.48	
XS 25	0.9	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.55	
XS 26	0.5	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.36	
XS 27	1.9	1.1	1.3	1.8	1.8	1.0	0.5	0.5	1.23	
XS 28	0.6	0.5	0.6	0.9	0.9	0.3	0.2	0.2	0.56	
XS 29	1.4	0.8	0.9	1.3	1.3	0.7	0.3	0.4	0.87	
XS 30	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.31	Reach 2 Avg
XS 31	0.8	0.5	0.5	0.8	0.8	0.3	0.2	0.1	0.50	Min
XS 32	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.30	Max
XS 33	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.07	
XS 34	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.08	
XS 35	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.08	Reach 3 Avg
XS 35.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	Min
XS 35.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.14	Max
XS 35.4	5.4	2.8	3.2	4.7	4.5	3.6	1.2	2.7	3.50	
XS 36	0.7	0.4	0.4	0.6	0.6	0.3	0.2	0.1	0.40	
XS 37	0.9	0.6	0.7	0.9	0.9	0.4	0.2	0.2	0.60	
XS 38	0.9	0.6	0.7	0.9	0.9	0.4	0.2	0.2	0.60	
XS 39	0.4	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 40	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 41	0.7	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 42	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.30	
XS 43	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.0	0.13	
XS 44	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 45	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.31	
XS 46	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.15	
XS 47	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.15	
XS 48	0.9	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.53	
XS 49	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 50	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 51	0.4	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.29	
XS 52	0.2	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.11	
XS 53	0.5	0.3	0.4	0.5	0.5	0.2	0.1	0.1	0.32	
XS 54	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 55	0.4	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 56	1.0	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.55	
XS 57	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.18	
XS 58	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.43	
XS 59	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 60	1.9	0.9	1.1	1.5	1.5	0.9	0.4	0.6	1.11	
XS 61	0.3	0.2	0.2	0.2	0.3	0.1	0.1	0.0	0.20	
XS 62	1.2	0.7	0.7	1.0	1.0	0.5	0.3	0.3	0.73	
XS 63	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.20	
XS 64	1.0	0.6	0.7	1.0	1.0	0.4	0.2	0.2	0.63	
XS 65	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.38	
XS 66	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.43	
XS 67	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.33	

Project: Poindexter Slough Incipient Motion - 100 CFS at Headgate (Includes GW Inputs and Dillon Canal Closed)

Engineer Date	TT 9/5/2012	Color Key: Red = manual input Green = HEC-RAS input Blue = calculated values
Suggested Input values:		
F* = Shield's pmt. =	0.03 (gravel/stone bed) 0.047 (sand bed)	ST = stability factor = 1.0-1.2: Uniform flow, straight to mildly curving, Rc/W>30, wave and debris impact minimal 1.3-1.6: Gradually varied flow, moderate bend, 10<Rc/W<30, wave and debris impact moderate 1.6-2.0: Approaching rapidly varying flow, sharp bend, Rc/w<10, significant impact, high turbulence, uncertainty in parameters
Gs = sediment spec. grav. =	2.65	
gamma w = unit weight of water =	62.4	
gamma s = unit weight of sediment =	165.4	
theta = repose angle (deg) =	typically 36° (30°-45°), set to 1 for sizing bed material	Ct = turbulence coefficient = 0.86 for high turbulence 1.2 for low turbulence
phi = bank angle (deg) =	26.5 for 2:1, 33.7 for 1.5:1, set to 0 for sizing bed material	
Rc = bend radius of curvature =	10,000 for straight reach measured value for bend use bankfull top width when flow is over banks	FS = safety factor = 1.0 (minimum) in straight reaches 1.25 in bends, high energy areas, and at abrupt changes in roughness 1.5 (minimum) for rounded stone
W = top width =		
Kb = bend factor =	1.0 for straight section 1.1-2.0 for bend (see attached Kb chart)	Cth = thickness coefficient = 1.0 when the thicker of (1"D100) and (1.5"D50) is used as RR blanket thickness
(Kb is automatically calculated)		

INPUT					
F*	Gs	gamma w	gamma s	theta	phi
0.03	2.65	62.4	165.4	36	26.5
g	Ct	Cth		Kb = 1.0 in columns below on straight reaches	
32.2	0.86	1			

Calculated K = 0.65

INPUT from HEC-RAS										
XS #	Q	A	Pw	d max	V ave	Se	Shear	W	Rc	Re/W
XS 1	100	28.16	17.19	3.74	4.14	0.0038	0.57	40	10000	250
XS 5	100	71.84	27.84	4.49	1.45	0.0003	0.07	40	10000	250
XS 1	100	37.12	21.33	2.64	2.69	0.0025	0.27	40	10000	250
XS 2	100	28.39	22.45	1.62	3.52	0.0066	0.52	40	10000	250
XS 3	100	68.14	39.71	3.05	1.07	0.0008	0.08	40	10000	250
XS 4	105.78	36.13	37.09	2.1	2.94	0.0055	0.38	40	10000	250
XS 5	103.71	43.35	35.54	1.59	2.39	0.0032	0.24	40	10000	250
XS 6	103.71	44.79	33.98	2.32	2.32	0.0027	0.22	40	10000	250
XS 7	107.49	38.06	33.15	1.36	2.72	0.0045	0.32	40	10000	250
XS 8	107.49	65	44.11	2.19	1.65	0.0012	0.11	40	10000	250
XS 9	107.49	69.68	34.63	2.81	1.54	0.0007	0.08	40	10000	250
XS 10	107.49	32.67	32.14	1.66	3.29	0.0077	0.49	40	10000	250
XS 11	107.49	53.36	29.72	3.02	2.01	0.0013	0.15	40	10000	250
XS 12	107.49	46.89	33.79	1.79	2.29	0.0025	0.21	40	10000	250
XS 13	107.49	78.4	40.78	3.78	1.37	0.0006	0.07	40	10000	250
XS 14	107.49	40.2	33.84	1.36	2.67	0.0041	0.31	40	10000	250
XS 15	107.49	83.5	49.68	3.38	1.37	0.0006	0.07	40	10000	250
XS 16	107.49	32.3	42.36	1.44	3.81	0.0104	0.65	40	10000	250
XS 17	107.49	108.5	56.58	4.23	0.99	0.0003	0.04	40	10000	250
XS 18	111.54	33.45	33.28	1.39	3.36	0.0068	0.49	40	10000	250
XS 19	111.54	42.03	25.96	2.46	2.86	0.0025	0.27	40	10000	250
XS 20	111.54	36.32	23.4	2.53	3.18	0.0033	0.37	40	10000	250
XS 21	111.54	56.06	40.88	2.79	2.08	0.0014	0.16	40	10000	250
XS 22	111.54	46.68	37.43	1.58	2.4	0.0029	0.24	40	10000	250
XS 23	111.54	52.07	53.22	1.67	2.19	0.0025	0.2	40	10000	250
XS 24	124.66	55.47	59.24	1.29	2.3	0.0032	0.23	40	10000	250
XS 25	124.66	64.73	38.06	2.88	1.94	0.0012	0.14	40	10000	250
XS 26	124.66	37.38	36.24	1.77	3.41	0.0059	0.48	40	10000	250
XS 27	124.66	52.93	32.75	2.72	2.36	0.0021	0.21	40	10000	250
XS 28	124.66	43.57	39.47	1.33	2.67	0.0050	0.36	40	10000	250
XS 29	124.66	70.24	46.59	2.73	1.77	0.0013	0.12	40	10000	250
XS 30	124.66	56.62	41.62	1.74	2.2	0.0023	0.2	40	10000	250
XS 31	117.36	75.48	46.45	2.84	1.56	0.0008	0.09	40	10000	250
XS 32	117.36	149.33	70.63	2.95	0.19	0.0001	0.02	40	10000	250
XS 33	117.36	140.98	60.64	4.73	0.83	0.0001	0.02	40	10000	250
XS 34	117.36	139.35	61.67	5	0.85	0.0001	0.02	40	10000	250
XS 35	122.72	167.13	59.44	4.48	0.76	0.0001	0.02	40	10000	250
XS 35.1	122.43	85.03	32.37	4.1	1.44	0.0004	0.07	40	10000	250
XS 35.3	122.43	20.79	20.36	1.17	5.89	0.0244	1.56	40	10000	250
XS 35.4	122.43	56.49	39.37	2.33	2.17	0.0021	0.19	40	10000	250
XS 36	122.43	44.99	40.13	2.81	2.84	0.0025	0.3	40	10000	250
XS 37	122.43	53.36	49.83	1.74	2.27	0.0034	0.23	40	10000	250
XS 38	122.43	69.65	39.39	2.7	1.76	0.0010	0.12	40	10000	250
XS 39	122.43	55.74	31.76	2.56	2.2	0.0017	0.18	40	10000	250
XS 40	122.43	58.48	39.64	2.96	2.09	0.0019	0.17	40	10000	250
XS 41	122.43	61.46	29.22	3.08	1.99	0.0011	0.14	40	10000	250
XS 42	122.43	88.65	39.19	3.53	1.38	0.0005	0.07	40	10000	250
XS 43	122.43	56.53	35.9	1.98	2.17	0.0019	0.18	40	10000	250
XS 44	122.43	63.27	39.27	2.22	1.93	0.0014	0.14	40	10000	250
XS 45	122.43	97.79	42.7	3.44	1.25	0.0004	0.05	40	10000	250
XS 46	122.43	85.01	37.63	3.42	1.44	0.0005	0.07	40	10000	250
XS 47	124.91	50.87	33.92	1.94	2.46	0.0025	0.24	40	10000	250
XS 48	124.91	57.3	33.96	3.04	2.26	0.0013	0.18	40	10000	250
XS 49	124.91	84.36	49.86	2.46	1.48	0.0008	0.08	40	10000	250
XS 50	124.91	65.67	35.28	3.37	1.9	0.0011	0.13	40	10000	250
XS 51	124.91	96.38	37.04	3.85	1.3	0.0003	0.06	40	10000	250
XS 52	124.91	61.86	40.22	1.97	2.02	0.0017	0.16	40	10000	250
XS 53	124.91	75.54	51.48	1.96	1.65	0.0012	0.11	40	10000	250
XS 54	124.91	71.92	50.51	2.94	1.74	0.0014	0.12	40	10000	250
XS 55	124.91	50.02	45.62	1.79	2.5	0.0040	0.27	40	10000	250
XS 56	127.7	84.23	50.6	2.07	1.52	0.0008	0.09	40	10000	250
XS 57	127.7	77.11	49.14	1.88	1.86	0.0011	0.11	40	10000	250
XS 58	127.7	80.42	39.57	3.51	1.59	0.0007	0.09	40	10000	250
XS 59	127.7	38.39	47.1	1.06	3.33	0.0105	0.54	40	10000	250
XS 60	127.7	78.51	42.33	2.46	1.63	0.0008	0.1	40	10000	250
XS 61	127.7	46.31	44.65	1.19	2.76	0.0052	0.34	40	10000	250
XS 62	127.7	79.69	39.82	4.11	1.6	0.0007	0.09	40	10000	250
XS 63	127.7	49.4	32.6	2.87	2.59	0.0028	0.26	40	10000	250
XS 64	127.7	59.07	32.31	3.3	2.16	0.0015	0.17	40	10000	250
XS 65	127.7	51.47	28.62	2.91	2.48	0.0020	0.23	40	10000	250
XS 66	127.7	64.76	38.42	2.04	1.97	0.0014	0.15	40	10000	250
XS 67	135.8	35.84	24.92	2.12	3.79	0.0064	0.58	40	10000	250

Mobile size (inches)										
XS #	Shields	ASCE	Cal DOH	USBR	Irbach	ACOE	Cal DOT	HEC-11	Average*	
XS 1	2.2	1.7	1.9	2.7	2.6	1.3	0.7	0.6	1.72	
XS 5	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 1	1.0	0.7	0.8	1.1	1.1	0.5	0.3	0.2	0.72	
XS 2	2.0	1.2	1.4	2.0	1.9	1.1	0.5	0.6	1.32	
XS 3	2.0	1.2	1.4	2.0	1.9	1.1	0.5	0.6	1.32	
XS 4	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.20	
XS 5	1.5	0.8	0.9	1.4	1.3	0.6	0.3	0.3	0.90	
XS 6	0.9	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.59	
XS 7	0.9	0.5	0.5	0.8	0.8	0.3	0.2	0.1	0.54	
XS 8	1.2	0.7	0.8	1.2	1.1	0.6	0.3	0.3	0.78	
XS 9	0.4	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.27	
XS 10	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.22	
XS 11	1.9	1.0	1.2	1.7	1.7	0.9	0.4	0.5	1.16	
XS 12	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.39	
XS 13	0.8	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.53	
XS 14	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.18	
XS 15	1.2	0.7	0.8	1.1	1.1	0.6	0.3	0.3	0.75	
XS 16	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 17	2.5	1.4	1.6	2.3	2.2	1.4	0.6	0.8	1.60	
XS 18	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.09	
XS 19	1.9	1.1	1.2	1.8	1.7	1.0	0.5	0.6	1.22	
XS 20	1.0	0.7	0.8	1.1	1.1	0.5	0.3	0.2	0.71	
XS 21	1.4	1.0	1.1	1.6	1.5	0.7	0.4	0.3	1.02	
XS 22	0.6	0.4	0.5	0.7	0.7	0.3	0.2	0.1	0.42	
XS 23	0.9	0.6	0.6	0.9	0.9	0.4	0.2	0.2	0.59	
XS 24	0.8	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.48	
XS 25	0.9	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.55	
XS 26	0.5	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.36	
XS 27	1.9	1.1	1.3	1.8	1.8	1.0	0.5	0.5	1.23	
XS 28	0.6	0.5	0.6	0.8	0.8	0.3	0.2	0.1	0.36	
XS 29	1.4	0.8	0.9	1.3	1.3	0.7	0.3	0.4	0.87	
XS 30	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.30	
XS 31	0.8	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.49	
XS 32	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.23	
XS 33	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 34	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 35	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 36	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.06	
XS 37	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 38	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 35	6.1	3.4	3.8	5.6	5.3	4.2	1.4	3.3	4.13	
XS 36	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.47	
XS 37	1.2	0.7	0.8	1.3	1.2	0.8	0.3	0.3	0.91	
XS 38	0.9	0.5	0.6	0.8	0.8	0.4	0.2	0.2	0.53	
XS 39	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.30	
XS 40	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.47	
XS 41	0.7	0.4	0.5	0.7	0.7	0.3	0.2	0.1	0.47	
XS 42	0.5	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.38	
XS 43	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.18	
XS 44	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.47	
XS 45	0.5	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.37	
XS 46	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	0.14	
XS 47	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.19	
XS 48	0.9	0.6	0.7	0.9	0.9	0.4	0.2	0.2	0.61	
XS 49	0.7	0.5	0.6	0.8	0.8	0.3	0.2	0.1	0.46	
XS 50	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.21	
XS 51	0.5	0.3	0.4	0.5	0.6	0.2	0.1	0.1	0.34	
XS 52	0.2	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.17	
XS 53	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.22	
XS 54	0.4	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.26	
XS 55	0.5	0.3	0.3	0.5	0.5	0.2	0.1	0.1	0.29	
XS 56	1.0	0.6	0.7	1.0	1.0	0.4	0.2	0.2	0.64	
XS 57	0.3	0.2	0.3	0.3	0.4	0.1	0.1	0.0	0.22	
XS 58	0.4	0.3	0.3	0.4	0.4	0.2	0.1	0.1	0.27	
XS 59	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 60	2.1	1.1	1.2	1.7	1.7	1.0	0.4	0.6	1.24	
XS 61	0.4	0.3	0.3	0.4	0.4	0.1	0.1	0.0	0.25	
XS 62	1.3	1.2	0.8	1.6	1.6	0.8	0.3	0.3	0.81	
XS 63	0.3	0.2	0.3	0.4	0.4	0.1	0.1	0.0	0.24	
XS 64	1.0	0.7	0.7	1.0	1.0	0.4	0.3	0.2	0.67	
XS 65	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.1	0.45	
XS 66	0.3	0.2	0.2	0.3	0.3	0.1	0.1	0.0	0.22	
XS 67	0.6	0.4	0.4	0.6	0.6	0.2	0.2	0.1	0.38	